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The Drilling and Blasting Must Be Given Special Attention by the Management. Here, too, Wide Spacing of the Drill Holes Makes Operation Impossible Until the Boulders Are Again Drilled and Reblasted

MANAGEMENT . . . . and Power Shovel Production In Highway Grading

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An analysis of the effect of operating characteristics on time losses and production rates as found in recent field studies on 51 power shovels.

THE rate of production secured from any given power shovel in highway grading work varies with many factors, the most important of which is generally the management. The kind and character of the materials, weather and working conditions, equipment and personnel, each in varying degree and from time to time, also impress their influence on the rate of production, but the effect of management is continuous and largely independent of all other factors. Thus, for example, poor blasting may readily reduce production to about one-half of normal, which poor or inefficient management is likely to accept and condone as an uncontrollable contingency, but which efficient management will simply meet as another difficulty to be licked and will at once begin to make determined efforts to overcome this new handicap and especially to prevent its recurrence in the next blast. Thus no matter what the other conditions may be, an effective change in the grade of management apparently produces a somewhat corresponding change in the rate of production. This is perhaps the most important conclusion which can be drawn from an analysis of the data obtained in recent field studies of 51 power shovels engaged in the highway grading work.

Full Dipper Loads Very Important in Securing High Production

What Efficient Management Involves.—Efficient management of power shovel grading work involves not only the proper selection of equipment and personnel but also the proper coordination, direction, and conduct of the various more or less independent operations. These latter are very important, for except when casting is possible, production is largely dependent on how well these associated operations are coordinated and directed. No matter how fast the shovel, nor how expert its operation, actual production can proceed only when and as hauling units are in place to receive the material. Nor does the necessity of managerial control and with the shovel and the operation of the hauling units. This coordinating direction must also extend to the dump, for the hauling units can haul no more material nor be operated more regularly than permitted by the conditions at the dump. Management must, therefore, not only insure that the shovel is operated at or near its maximum capacity rate for the given material and conditions, but it must also see that the supply of hauling units is correct and that they are properly loaded, handled and operated with almost clocklike precision. It must also see that the dump operations are sufficient to absorb the material without delay or interruption to the regular, steady operation of the hauling units. If the materials require blasting, management is charged with insuring not only that this is performed properly for efficient shovel operation, but that it is carried on without interference or delay to any of the other coordinated operations.

The Ideal of Perfect Coordination.—The rate of actual production secured under any given set of conditions on a given job, therefore, depends very largely on how nearly management can succeed in approaching this ideal of perfect coordination under which production might proceed continuously at capacity rate and without any unnecessary interruptions or delays. In power shovel grading work on any given job the deviations from this ideal appear mainly as minor time losses or operating delays to the shovel, which is the primary producer. The extent of these minor delays or interruptions to continuous operation during working hours can readily be measured with a stop-watch and made a matter of record.

But not all of these operating delays are due to any fault of the management. Some, such as, for example, moving the shovel forward in the cut, are necessary to the continuation of the work and all that management can do is to see that they are performed properly and without unnecessary delay. Most delays due to breakdowns should also be placed in this class. On the other hand, such delays as, for example, those arising from interference or improper operation of the equipment and the use of improper methods must lie at the door of management.

A Measure of Relative Efficiency.—A comparison of the time losses or delays which are amenable to control by the management, therefore, gives us a measure for evaluating the relative efficiency of the management on different jobs. Since conditions are never exactly the same on any two grading jobs, this measure is admittedly not precise but is apparently definite enough to distinguish readily between good and poor management. This is as far as the present study has attempted to differentiate between the grades of management and in noting the effect of good and poor management on production rates. In fact, most of the present study will be devoted to noting the extent to which production rates deviate from what, for want of more definite classification means, we might term as average management, or that found on a majority of grading jobs.

Above: In Power Shovel Work Management Must Watch Every Second of the Repetitive Cycles. A Short Swing and Free and Easy Movement of Trucks Are Prerequisites. Here Trucks Load Alternately on Right and Left of Shovel. The Clean, Smooth Pit Facilitates Easy Movement of Trucks

Left: Here Poor Management Permits 3 or 4 Seconds to Be Added to Every Dipper Load: A Reduction of 15 to 20 Per Cent in Production

To illustrate more particularly the extent to which the management affects production, the essential data for nine high-time-loss and eight low-time-loss jobs have been compiled in Tables I and II. Since many years of experience have shown that the rate of production on power shovel grading jobs generally varies with the proportion of the working time lost in minor delays, these 17 jobs were selected from the full list of 51 jobs given in Table VII as the 8 having the lowest percentage of working time lost in minor delays and the 9 jobs having the largest losses from such delays. The shovels were all in fair to good condition. The first group con-

tains six 1¼-yd. and two 1½-yd. shovels while the other group contains four 1¼-yd. and two 1-yd. shovels with one each of ¾, 1½ and 1¾ yd. capacity.

High and Low-Loss-Time Jobs Compared.—This table reveals several interesting facts: First, the average percentage of working time lost in minor stops, delays or interruptions each of less than 15 minutes in duration was 47.8 per cent for the first group as against only 23.4 per cent for the second group, or the time loss of the higher group was slightly more than twice that of the lower; second, the average production secured was 57.8 cu. yd. per working hour for the first group and 113.7 cu. yd. per working hour for the low-time-loss group, which is almost double the production rate secured from the shovels of the first group. Yet the shovels of the second group operated but little faster than those of the first group. In fact, the average operating cycle of the shovels of the first group was 24.9 seconds while it was 21.1 second for the second group—a difference of only 18 per cent in operating speed as compared with a difference of 97 per cent in production. The difference in production rates between the two groups of shovels is, therefore, evidently not due, in any large

TABLE I.—PRODUCTION RATES AND OPERATING CHARACTERISTICS ON JOBS WITH LARGE AND WITH SMALL MINOR TIME LOSSES

Job No.	Total minor time loss Per cent	Actual operating time Per cent	Average production per working hour Cubic yards	Dipper size Cubic yards	Shovel cycle Seconds	Average dipper load Cubic yards
	Jobs with High Minor Time Losses					
3	45.1	54.9	53.2	0.75	20.6	0.55
28	53.9	46.1	42.8	1.25	26.7	0.68
30	42.3	57.7	71.5	1.25	26.1	0.88
31	41.5	58.5	49.5	1.00	26.8	0.61
32	55.1	44.9	44.3	1.25	31.5	0.86
42	48.5	51.5	61.6	1.25	22.5	0.75
43	55.7	44.3	68.5	1.00	17.6	0.76
48	46.2	53.8	56.6	1.50	25.4	0.80
49	42.0	58.0	72.0	1.75	27.2	0.93
Average	47.8	52.2	57.8	1.22	24.9	0.76
Av. 1¼-yd. shovels	50.0	50.0	55.0	1.25	26.7	0.79
	Jobs with Low Minor Time Losses					
8	22.2	77.8	105.0	1.25	22.9	0.86
15	24.6	75.3	71.0	1.25	29.1	0.76
17	24.1	75.9	100.5	1.50	24.3	0.98
19	24.9	75.1	79.3	1.50	21.0	0.62
20	22.0	77.9	127.6	1.25	17.6	0.79
21	23.3	76.7	150.3	1.25	16.1	0.88
36	20.9	79.1	150.5	1.25	19.3	1.01
37	25.0	75.0	125.0	1.25	18.5	0.88
Average	23.4	76.6	113.7	1.31	21.1	0.85
Avg. 1¼-yd. shovels	23.0	77.0	121.6	1.25	20.6	0.86

Above: A Good Bulldozer Is an Essential Piece of Equipment on Most Power Shovel Grading Jobs

Right: Good Management Usually Insists on a Clean and Smooth Loading Pit and the Proper Maintenance of the Hauling Road

TABLE II.—MINOR TIME LOSSES ON 17 SELECTED PROJECTS—TIME LOSSES SHOWN IN PERCENTAGE OF WORKING TIME

	High Time Loss, Low-Production Jobs										Low Time Loss, High-Production Jobs								
Project No.	3	28	30	31	32	42	43	48	49	Avg.	8	15	17	19	20	21	36	37	Avg.
Trucks, supply	19.2	5.3	10.6	8.5	15.7	3.1	15.1	4.5	0.5	9.2	4.3	0.6	5.9	5.8	1.6	2.1	1.0	7.7	3.6
Trucks, operation	3.9	8.3	3.7	4.0	4.4	10.0	13.5	1.3	9.4	6.5	5.3	5.5	5.5	1.2	0.5	0.7	0.6	1.3	2.6
Shovel, moving	7.1	7.0	7.2	2.7	3.4	5.1	6.9	7.4	6.4	5.9	2.4	5.5	3.8	6.6	3.4	5.4	5.5	3.9	4.6
Shovel, repair mech.	1.6	3.4	1.4	..	2.7	2.1	4.2	2.4	2.2	2.2	1.8	2.4	1.7	0.5	0.4	0.5	1.5	1.8	1.3
Shovel engine trouble	..	0.9	0.4	1.5	..	..	..	0.4	4.8	0.9	..	..	..	..	1.6	1.8	0.7	0.4	0.6
Shovel operator	0.8	1.9	..	1.0	1.8	1.2	0.6	0.4	2.6	1.1	0.3	0.6	0.6	0.4	0.2	0.2	1.2	0.5	0.5
Shovel fuel, water	..	..	0.2	0.5	1.7	..	0.2	..	..	0.3	..	..	..	..	..	..	..	..	0.0
Rock, roots, stumps	4.7	16.1	13.0	21.9	24.2	0.4	0.5	15.5	11.9	12.0	3.7	3.8	2.8	2.7	9.9	6.3	0.9	3.2	4.2
Blasting	..	..	..	1.4	0.8	..	..	1.4	..	0.4	..	..	..	..	0.6	0.3	..	..	0.1
Grading, sloping and checking grade	1.9	9.2	5.1	..	0.4	24.1	14.3	10.5	3.1	7.7	1.1	3.1	2.2	2.4	3.3	5.0	6.8	5.2	3.6
Miscellaneous	5.9	1.8	0.7	..	..	2.5	0.4	2.4	1.1	1.6	3.3	3.1	1.6	5.3	0.5	1.0	2.7	1.0	2.3
Average job totals	45.1	53.9	42.3	41.5	55.1	48.5	55.7	46.2	42.0	47.8	22.2	24.6	24.1	24.9	22.0	23.3	20.9	25.0	23.4

Proper Selection and Coordination of the Equipment Is One of the Important Functions of Management. Hauling Units of Less Than Two Dipper Capacity Are Not Conducive to High Production

TABLE III.—AVERAGE PERCENTAGE OF ACTUAL WORKING TIME LOST IN MINOR DELAYS FROM VARIOUS CAUSES ON 51 RECENT POWER SHOVEL GRADING JOBS, TOGETHER WITH MAXIMUM AND MINIMUM TIME LOSSES FROM THESE CAUSES ON ANY INDIVIDUAL JOB

Cause of Delay	Average for all jobs	Any Individual Job Maximum	Any Individual Job Minimum
Hauling Equipment:	Per cent	Per cent	Per cent
Supply	5.2	17.3	0.5
Operation	4.7	13.5	0.5
Subtotal—average and individual job values	9.9	28.6	1.6
Shovel:			
Moving	5.0	9.8	1.7
Repairs and adjustments	1.9	4.3	0.4
Engine trouble	0.7	4.8	0.0
Operator	1.5	3.9	0.2
Subtotal—average and individual job values	9.1	16.0	4.0
Subtotal—exclusive of moving shovel	4.1	7.7	0.9
Rocks, roots and stumps	6.9	26.6	0.5
Sloping banks and smoothing grade	4.6	12.7	0.0
Blasting	0.3	3.7	0.0
Checking grade	0.3	11.7	0.0
Miscellaneous causes	2.1	5.9	0.0
Average for all jobs and maximum and minimum values of individual jobs	33.2	55.7	20.9

extent, to any difference in operating speeds but far more to more continuous operation and larger average dipper loads. This becomes even more apparent if we consider only the shovels of the same size in each group, those of 1¼-yd. size. For these we find that the minor time losses mounted to 50 per cent of the working time for the four 1¼-yd. shovels in the first group and only 23.0 per cent for the six 1¼-yd. shovels in the second group, while the production per working hour was respectively 55.0 and 121.6 cu. yd. and the average dipper loads 0.79 and 0.86 cu. yd. Here only about 30 per cent of the increase is due to the faster operating cycle of the well-managed jobs. The other 70 per cent of the increased production is due to the steadier operation and larger dipper loads, especially the steadier operation.

Good Management Results in Low-Time-Losses.—It is not contended, however, that all of this difference in the production rates of the two groups of shovels was due to differences in the degree of management. An undetermined amount was no doubt due to conditions entirely independent of management such as differences in the materials and weather and working conditions, since no two jobs are ever exactly comparable as to all these conditions. But such functions as the selection of the proper equipment, the development of efficient and effective working methods, the proper coordination of the various operations, and the creation of an alert and vigorous organization are essentially functions of the management. And while existing field conditions and economic requirements always impose many limitations as to how or in what way management may act, they do not in any way abrogate or usurp any of its real functions, but only serve to limit or circumscribe the scope within which they may be utilized effectively. Where, as in grading work, such limitations are numerous, the question of whether a certain effect is due to management or to some other cause is, therefore, sometimes difficult to determine. This much, however, seems established by these studies: high-grade management almost invariably is associated with a relatively low minor time loss while low-grade management almost equally invariably shows a relatively high time loss. Furthermore, for materials at all comparable, production rates almost invariably increase as the minor time losses decrease.

Loading Large Hauling Units on a Bench Above the Shovel Is an Operation Which the Management Must Watch Carefully. Reaching To or Near the Limit of the Shovel Is Apt to Be Very Time-Consuming

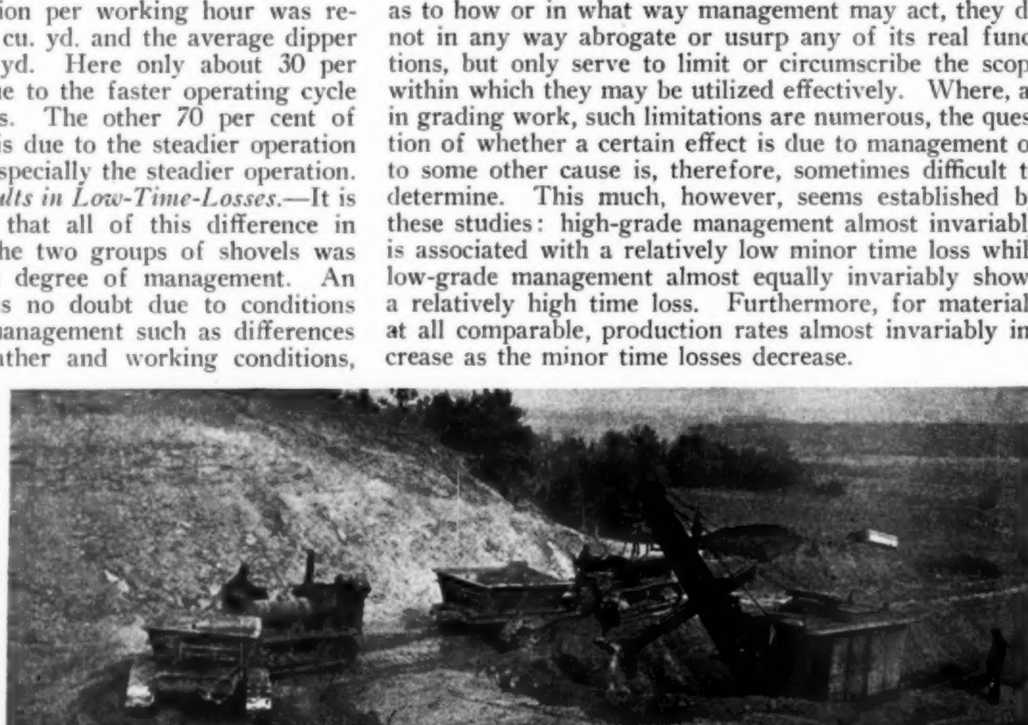


TABLE IV.—AVERAGE PERCENTAGE OF AVAILABLE TIME LOST IN MAJOR DELAYS FROM VARIOUS CAUSES ON 51 POWER SHOVEL GRADING JOBS TOGETHER WITH MAXIMUM AND MINIMUM TIME LOSS FROM THESE SAME CAUSES ON ANY INDIVIDUAL JOB

Cause of Delay	Average for all jobs Per cent	Any Individual Job Maximum Per cent	Any Individual Job Minimum Per cent
Weather:			
Rain	7.1	26.6	0.0
Wet grade on road	4.0	19.6	0.0
Cold and snow	3.8	40.8	0.0
Subtotal—average and individual job values	14.9	58.8	0.0
Shovel:			
Moving	1.7	6.3	0.0
Repairs	6.6	23.0	0.0
Engine trouble	0.6	6.7	0.0
Cable replacements	0.2	2.0	0.0
Take on fuel or water	0.1	1.4	0.0
Operator	0.3	1.5	0.0
Subtotal—average and individual job values	9.5	24.5	0.3
Drilling and blasting	1.9	10.6	0.0
Hauling equipment	0.2	2.8	0.0
Open new cuts	1.1	20.7	0.0
Sloping banks and smoothing grade	0.4	8.7	0.0
Dump difficulties	0.6	12.2	0.0
Slides and flood damages	0.5	9.7	0.0
All miscellaneous causes	1.3	5.4	0.0
Average for all jobs and maximum and minimum values of individual jobs	30.4	64.4	5.8

Trying to Make the Shovel Take the Place of Blasting Is One Frequent Manifestation of Poor Management

It is only natural that this should be so. The first and most obvious point for management to attack in any attempt to increase production rates is, of course, the elimination or reduction of repetitive times losses or delays. As these are reduced, the time so gained can usually be largely or entirely utilized in securing additional production.

Coordination of Excavating, Hauling and Dumping.—Sometimes, however, certain changes or additions must be made before the time so gained can be converted into actual production. Thus, if it were found that a shovel working regularly on a 25-second cycle of which 5 seconds involved delays and lost motion capable of ready elimination, the shovel cycle could soon be reduced to 20 seconds permitting a 25 per cent increase in production. But if the four trucks on the job were only just sufficient to handle the production on the 25-second cycle, then a reduction of the cycle delays so as to obtain a 20-second shovel cycle would be of no value until another truck was added to take care of the additional yardage which the shovel was now capable of producing. Thus in highway grading work the shovel is the primary producing unit and its pace can never be exceeded. But, in order that the full rate of the shovel may be maintained, the hauling units must be able to handle this full shovel rate and the dump must be able to dispose of it. If the material must be blasted, the drilling and shooting must also proceed with at least the rate set by the shovel and without interference to any of the other operations. These factors which so greatly affect the rates of production are all under more or less complete control of the management.

Loss of Working Time Due to Minor Delays.—The large variations in the amount of working time lost by each of the 51 shovels in minor stops or delays also present some interesting considerations. Thus, while the

A Truck Equipped For Easy Operation in Both Forward and Reverse

TABLE VI.—MAJOR TIME LOSSES—SUMMARY OF 51 JOBS

Cause	Total Available Time Lost Hours	Per cent
Rain	1,334.47	7.1
Wet grade	746.82	4.0
Cold and snow	715.32	3.8
Move shovel	323.84	1.7
Repair, mechanical	1,241.91	6.6
Cable	42.31	0.2
Engine	120.80	0.6
Fuel and water	21.02	0.1
Shovel operator	46.00	0.3
Hauling equipment	29.73	0.2
Drilling and blasting	346.98	1.9
Open cuts	213.36	1.1
Grading and sloping	65.42	0.4
All others	450.72	2.4
Total	5,698.70	30.4
Rocks	29.15	0.2
Management	42.23	0.2
Dump	117.18	0.6
Slides and flood damage	87.33	0.5
Miscellaneous	174.83	0.9
Total, all others	450.72	2.4

average time loss in minor stops or delays was 33.2 per cent for all of the jobs, it was as low as 20.9 on one job and as high as 55.7 on another. These losses for each of the principal causes are shown in Table III, first for the average of all the jobs, second for the maximum value of each item on any one of the 51 jobs, and finally for the lowest or minimum value for each item as found on any one given job. Both maximum and minimum values seem to be rather widely variant. In no case was any one job found to have a maximum value for any two of the separate items. Thus while the maximum minor time loss on any one job amounted to 28.6 per cent for the two items of hauling equipment supply and hauling equipment operation, the sum of the maximum values of each of these items from separate jobs gives a total of 30.8 per cent. Even more striking are the maximum values for the four items: Moving shovel, shovel repairs and adjustments, engine trouble, and the functions generally under the full control of the shovel operator. The maximum value of all these four items on any one single job was 16.0, but the independent maximum values of each of these items on individual jobs present a total value of 22.8 per cent. And while the maximum minor time loss on any one job was 55.7 per cent the sum of the independent maxima for all the various jobs for the 11 different items amounts to the rather astonishing total of 114.2 per cent.

What has been said of the maximum values for the minor time losses is also generally applicable in a reverse sense to the minimum values. Thus while the minimum values for hauling equipment supply and hauling equipment operation are each 0.5 per cent, the minimum value of these two items on any one job was 1.6 per cent. Furthermore, while the minimum time loss on any one job was 20.9 per cent, the sum of each of the 11 individual minima for the entire group of jobs was only 3.8 per cent. Thus any one job might be extremely high or extremely low on some one item but never on several items. This is only natural. If the shovel is idle, say, 25 per cent of the working time waiting for trucks. the percentage available for work during which the other delays might occur is at once reduced by one-fourth.

In considering the average time losses we find that 9.9 per cent of the working time was lost through lack of sufficient hauling equipment or through its improper operation. Both of these items are under full control of the management. Time losses connected with the

TABLE V.—MINOR TIME LOSSES—SUMMARY OF 51 JOBS

Cause of Delay	Hours	Per cent
Hauling equipment, supply	676.15	5.2
Hauling equipment, operation	623.60	4.8
Shovel, moving	661.80	5.0
Repairs and adjustments	249.73	1.9
Engine trouble	89.50	0.7
*Operator	200.42	1.5
Roots, rocks and stumps	900.48	6.9
Sloping and smoothing grade	596.28	4.6
Blasting	34.28	0.3
Checking grade	32.32	0.2
Miscellaneous	271.18	2.1
	4,335.74	33.2

*Includes stops for taking on fuel.

Working time	13,053.44 hours
Time lost	4,335.74 hours
Net fully utilized working time	8,717.70

Notes:

The average dipper load moved by the 28 1¼-yd. shovels = 0.80 cu. yd.

Average for all 51 shovels = 0.82 cu. yd.

DIPPER SIZES

Number of Shovels	Capacity Cu. Yd.
1	¾
1	⅞
9	1
28	1¼
7	1½
2	1¾
1	2
2	2¼

TABLE IX.—EFFECT OF CHARACTER OF MATERIAL ON TIME REQUIRED TO LOAD DIPPER

Job No.	Loading time, Seconds	Character of Material Fair to Easy Material
43	5.6	Earth, good.
42	5.8	Earth, good.
18	6.4	Fairly well blasted rock, ⅓ cast.
16	7.9	Fairly well blasted decomposed granite.
21	7.0	Well blasted shale and sandstone, some earth.
37	7.4	Earth and well blasted sock rock, some frost.
20	7.5	Well blasted shale and sandstone, some earth.
5	7.8	Red clay, schists and sandstone, fairly well blasted.
23	9.0	Mostly sand, clay gravel and some blasted schist.
26	8.0	Fairly well blasted granite and talus slopes, some earth.
36	8.2	Good clay with a few boulders.
22	8.2	Cemented gravel and boulders, some shale—shovel slow.
2	8.4	Earth and some rock, mostly shallow cuts.
24	8.4	Cemented gravel and boulders, some schist blasted.
38	8.3	Sandy earth and soft sandstone, some frost.
Avg....	7.6	

Job No.	Loading time, Seconds	Character of Material Difficult Material
29	16.7	Very poor blasted hard granite.
1	13.1	Earth and some rock, shallow cuts.
48	11.6	Rock and slate, fairly well blasted, small trucks.
15	11.8	Poorly blasted, partly decomposed granite.
30	11.5	Earth and some poorly blasted rock.
6	11.1	Laminated sandstone, light blasting, tilted strata.
28	11.0	Shallow cuts, many boulders.
40	11.0	Earth, some rock, well blasted.
33	10.8	Earth and poorly blasted limestone.
11	10.7	Clay with limestone boulders.
25	10.7	Fairly well blasted granite, much finishing work.
46	10.5	Fairly well blasted rock and shale.
34	10.4	Earth and boulders with poorly blasted limestone full of clay seams.
32	10.3	Poorly blasted hard rock.
41	10.0	⅔ earth, ⅓ poorly blasted rock.
Avg...	11.4	

TABLE VII—MINOR TIME LOSSES FOUND FROM STOP-WATCH STUDIES ON 51 GRADING JOBS—(ALL DATA IN HOURS)

	Hauling		Shovel				Rocks	Grading					
Job. No.	Supply	Operator	Moving	Repairs	Engine trouble	Operator	Rocks and stumps	Grading and clean up	Sloping	Blasting	Checking grade	Miscellaneous	Total
1	7.92	6.87	10.94	4.85	...	2.09	3.39	...	21.73	...	5.35	6.41	69.55
2	13.31	7.82	13.55	6.96	...	2.51	1.79	...	29.80	...	2.71	7.94	86.39
3	19.00	3.88	6.96	1.50	...	0.75	4.62	...	1.86	...	...	5.85	44.50
4	16.41	11.31	16.68	1.73	0.88	3.76	2.12	...	15.15	...	...	4.81	72.85
5	39.61	11.83	13.39	1.16	0.47	1.82	5.76	...	9.78	...	...	3.66	87.48
6	3.94	8.76	4.61	5.21	0.55	1.29	9.55	2.26	...	4.45	...	2.53	43.15
7	25.07	4.65	8.32	7.88	3.19	3.55	20.81	...	...	...	...	7.53	81.00
8	2.37	2.97	1.33	1.02	...	0.17	2.04	0.61	...	...	...	1.82	12.33
9	19.95	10.74	10.62	5.17	5.47	6.43	21.52	...	...	...	...	8.01	87.91
10	22.28	3.95	8.41	1.43	0.21	3.04	4.74	...	5.25	...	...	1.73	51.04
11	11.83	3.79	4.84	1.21	2.26	1.28	5.37	...	1.48	...	...	3.89	35.95
12	44.88	58.14	25.39	17.17	6.37	16.33	31.04	...	*18.54	1.56	...	9.17	228.58
13	19.15	23.56	13.05	3.97	2.95	8.99	12.11	...	* 8.54	0.86	...	2.25	95.43
14	49.58	90.71	57.81	21.24	4.14	23.84	47.32	...	27.51	6.21	...	20.17	348.53
15	2.57	19.83	20.19	8.61	...	2.08	8.47	11.41	...	...	0.11	16.99	90.26
16	5.31	11.73	17.35	6.39	7.43	6.72	4.74	16.48	...	...	...	11.37	87.52
17	30.62	29.06	20.30	8.42	...	2.93	15.02	10.81	...	..	...	8.63	125.79
18	1.67	17.65	10.85	4.02	...	0.33	3.17	...	5.16	...	...	3.33	46.18
19	12.26	2.74	14.23	1.16	...	0.80	5.73	...	* 5.02	...	...	11.34	53.28
20	7.66	2.28	16.88	1.79	7.95	0.84	48.70	15.00	1.56	2.95	...	2.69	108.30
21	7.26	2.41	18.10	1.60	6.06	0.37	21.12	14.90	1.56	1.15	...	3.12	77.65
22	4.15	6.49	11.82	7.66	2.68	2.12	4.19	10.53	0.69	...	...	10.81	61.14
23	11.01	31.50	10.36	6.25	4.74	1.65	13.59	13.13	4.84	...	...	10.85	107.92
24	17.59	30.54	9.43	8.30	1.70	3.62	14.37	7.87	4.59	...	...	4.53	102.54
25	7.30	1.84	10.89	3.19	0.14	2.03	5.41	11.55	5.54	...	...	5.29	53.18
26	5.84	4.33	17.03	3.56	1.08	4.80	12.41	16.32	6.66	...	...	5.70	77.73
27	14.87	18.29	28.05	9.26	...	8.54	23.48	17.02	14.07	0.76	0.34	7.19	141.87
28	7.43	11.70	9.86	4.76	1.23	2.73	22.61	12.06	0.90	...	...	2.32	75.60
29	1.44	4.05	3.87	0.59	0.21	2.55	10.41	3.05	0.14	...	0.10	0.69	27.10
30	13.43	4.61	9.13	1.89	0.50	0.16	16 34	5.42	0.88	...	0.14	1.02	53.52
31	12.04	5.67	3.81	...	2.10	2.08	31.02	...	...	1.92	...	...	58.64
32	17.39	4.88	3.82	2.97	...	4.00	26.94	...	...	0.90	0.43	...	61.33
33	12.17	21.65	28.28	10.67	6.78	4.28	74.57	...	*46.27	1.05	0.66	10.93	217.31
34	5.10	5.42	14.63	12.71	0.24	7.48	76.95	...	* 6.40	1.09	...	6.06	136.08
35	5.31	4.87	15.89	1.74	1.15	1.56	8.61	...	* 8.80	...	...	1.56	49.49
36	0.51	0.32	2.84	0.74	0.35	0.62	0.45	...	* 3.51	...	...	1.40	10.74
37	4.96	0.83	2.53	1.17	0.27	0.32	2.04	...	3.00	...	0.33	0.61	16.06
38	1.96	1.77	8.25	4.24	0.63	1.10	1.72	7.33	5.27	...	0.52	1.42	34.21
39	22.25	2.08	5.54	2.39	...	1.18	4.84	3.68	1.86	...	0.28	...	44.10
40	52.76	21.06	49.11	14.56	12.85	46.99	75.99	...	16.82	...	...	19.01	309.15
41	13.87	35.12	4.11	4.95	...	0.74	23.02	...	* 2.35	...	0.64	3.99	88.79
42	3.55	11.65	5.99	2.42	...	1.44	2.57	14.50	...	...	13.72	0.88	56.72
43	15.19	13.50	6.95	4.24	...	0.80	0.50	7.69	...	...	6.68	0.39	55.94
44	2.52	3.66	1.98	0.62	...	0.65	2.99	1.17	0.11	...	...	1.45	15.15
45	11.84	11.32	8.84	2.88	...	0.55	8.43	...	6.00	0.50	0.29	3.84	54.49
46	12.39	8.42	5.32	2.60	...	1.29	5.31	8.69	3.00	...	...	5.77	52.79
47	0.85	6.00	3.77	0.38	...	0.46	0.90	2.91	1.64	...	...	1.10	18.01
48	35.06	10.56	58.96	19.05	3.55	3.71	122.52	...	*83.01	10.88	...	18.75	366.05
49	0.14	2.68	1.86	0.63	1.37	0.75	3.44	...	* 0.90	...	...	0.30	12.07
50	0.58	2.89	3.93	1.41	...	0.60	12.04	...	* 0.98	...	0.02	1.61	24.06
51	...	1.32	1.15	1.33	...	1.72	13.69	...	* 0.72	...	...	0.47	20.40
Total	676.15	623.60	661.80	249.73	89.50	200.42	900.48	214.39	381.89	34.28	32.32	271.18	4,335.85

*Grading and clean-up included.

shovel or its operation amounted to 9.1 per cent of the working time, but of this 5.0 per cent arose from performance of the essential and necessary operation of moving the shovel forward in the cut. Minor repairs and adjustments to the shovel and engine trouble consumed only 2.6 per cent of the working time, a striking tribute to the sturdiness and reliability of the modern power shovel. Even major repairs, adjustments and replacements of all kinds, consumed an average of only 7.4 per cent of the total available time of the shovel while on the job. An average of 1.5 per cent was charged against the shovel operator and operations over which he had control. A goodly portion of these are therefore indirectly chargeable to the management.

Major Time Losses.—Major time losses as shown in Tables IV and VI consumed an average of 30.4 per cent of the total available working hours during which the shovels were on the job. These major time losses include all stops, delays and interruptions to production, each of 15 minutes or more in duration which occurred during the progress of the normal working hours within the period that the shovel was on the job. Of these major time losses, the largest single group is those due to weather causes over which management obviously has no direct control and which amounted to 14.9 per cent of the total available time. Of this loss, 11.1 per cent was due to rain and wet ground while only 3.8 per cent was due to cold, snow and frost. This cold weather loss would no doubt have been larger had a greater percentage of the jobs been located in the northern half of

TABLE VIII.—AVERAGE SHOVEL CYCLES ON 51 GRADING JOBS

Job No.	Load Seconds	Swing Seconds	Dump Seconds	Return Seconds	Cycle Seconds	Angle of swing, deg.	Kind, Character, and Condition of Material as Affecting Rate of Shovel Operation
1	13.1	7.2	1.9	7.9	30.1	109	Earth and some rock, mostly shallow cuts.
2	8.4	7.7	2.2	8.3	26.6	126	Earth and some rock, mostly shallow cuts.
3	9.3	5.4	2.0	3.9	20.6	80	Red clay with some schist and sandstone, fairly well blasted.
4	9.1	4.6	2.7	5.3	21.7	61	Red clay with some soft rock.
5	7.8	4.0	1.9	3.6	17.3	60	Red clay, schist and sandstone, fairly well blasted.
6	11.1	6.9	2.3	8.1	*28.4	101	Laminated limestone, light blasting, tilted strata.
7	9.1	6.1	2.2	6.3	23.7	83	Fairly well blasted sandstone and schist, some earth and hard pan.
8	8.7	5.7	2.8	5.7	22.9	75	Fairly well blasted sandstone and schist, some soft.
9	9.5	5.5	1.6	5.6	22.2	74	Fairly well blasted sandstone and schist, some soft.
10	8.9	6.0	4.0	6.4	25.3	88	Clay and rock.
11	10.7	5.9	3.7	5.6	25.9	65	Clay and limestone boulders.
12	9.7	5.4	3.2	5.5	*23.8	70	Poorly blasted limestone.
13	9.1	7.3	2.3	8.0	*26.7	114	Fairly well blasted limestone.
14	9.7	5.2	3.1	5.3	23.3	65	Clay and fairly well blasted limestone.
15	11.8	7.6	2.2	7.5	29.1	146	Poorly blasted partly decomposed granite.
16	7.4	5.8	1.2	6.0	20.4	126	Fairly well blasted partly decomposed granite.
17	9.0	6.8	1.4	7.1	24.3	139	Poorly blasted shale and sandstone.
18	6.4	3.6	2.2	4.3	16.5	60	Fairly well blasted rock and earth, ⅓ cast.
19	8.9	4.8	1.7	5.6	21.0	88	Mostly poorly blasted rock, ⅓ cast.
20	7.5	4.1	1.5	4.5	17.6	96	Well blasted shale and sandstone, some earth.
21	7.0	3.5	1.3	4.3	16.1	83	Well blasted shale and sandstone, some earth.
22	8.2	7.6	3.5	7.0	26.3	97	Mostly cement gravel with boulders, some shale, shovel old and slow.
23	8.0	8.0	3.2	7.1	26.3	105	Mostly sand and clay—gravel and some blasted schist.
24	8.4	6.3	2.8	6.2	23.7	75	Mostly cemented gravel with boulders and some schist.
25	10.7	5.9	1.5	6.6	*24.7	74	Fairly well blasted granite, much finishing work.
26	8.0	5.7	1.7	6.5	21.9	84	Fairly well blasted granite and talus slopes, some earth.
27	9.9	6.0	1.3	6.7	23.9	104	Rock and talus fairly well blasted; pioneering.
28	11.0	6.8	1.6	7.3	26.7	129	Shallow cuts with many boulders.
29	16.7	8.6	3.5	9.1	37.9	130	Very poorly blasted hard granite.
30	11.5	6.0	2.0	6.6	26.1	85	Earth and some poorly blasted rock.
31	9.0	7.4	2.8	7.6	26.8	122	Well blasted hard rock and shale.
32	10.3	8.5	4.5	8.2	31.5	135	Poorly blasted hard rock.
33	10.8	6.4	3.6	6.1	26.9	120	Earth and poorly blasted limestone full of clay steams.
34	10.4	6.4	3.5	5.8	26.1	108	Earth and boulders, poorly blasted limestone full of clay seams.
35	9.0	4.3	2.0	4.4	19.7	75	Earth with a few poorly blasted limestone seams.
36	8.2	4.0	2.9	4.2	19.3	61	Good clay with a few boulders.
37	7.4	4.9	1.1	5.1	18.5	47	Earth and well blasted soft rock, some frost.
38	8.3	5.1	1.3	5.1	19.8	76	Sandy earts and soft rock, some frost.
39	9.0	4.7	1.8	5.7	21.2	63	Sandy earth, some frost.
40	11.0	5.6	3.0	7.0	26.6	108	Earth, some rock well blasted.
41	10.0	5.3	3.5	5.3	24.1	97	⅓ rock poorly blasted, ⅔ earth.
42	5.8	5.2	6.2	5.3	22.5	50	Earth, good.
43	5.6	4.9	2.3	4.8	17.6	60	Earth, good.
44	9.5	6.4	1.2	6.8	23.9	130	Fair to poorly blasted rock, pioneering.
45	8.8	5.4	1.1	5.6	20.9	105	Fairly well blasted rock and shales.
46	10.5	6.7	1.3	6.8	25.3	141	Fairly well blasted rock and shales.
47	9.8	7.0	1.3	7.2	25.3	81	Fair to poorly blasted rock, much clean up.
48	11.6	5.7	2.6	5.5	*25.4	119	Rock and slate, fair blasting—small trucks.
49	9.9	7.2	2.3	7.8	27.2	105	Fairly well blasted rock, shovel slow, poor conditions.
50	9.6	9.2	3.6	9.8	32.2	154	Hard shale, fairly well blasted, inexperienced operator.
51	9.0	6.9	3.5	7.5	26.9	110	Poorly blasted stratified rock, dipping away from shovel.
Average.	9.6	6.0	2.4	6.2	24.2	95	

the United States. The 51 jobs, however, appear to be sufficiently distributed both throughout the usual working season of the year and throughout the main climatic zones to form a rather fair indication of average operating conditions as found on the ordinary power shovel highway grading job.

Effect of Character of Material.—In trying to evaluate or estimate the relative importance of management in its bearing on production, the question of the effect of the kind and character of the materials must not be forgotten. These vary greatly from job to job. In fact, it might almost be said that no two jobs ever have materials which are exactly alike in all respects. Tables VIII, IX, and X have therefore been prepared to illustrate more fully the effects which might possibly be due to differences in material and especially the extent to which such causes may have influenced the production rates of the 17 jobs selected for Table I. The general type of the materials, however, appears to be fairly similar for the two groups of high- and low-production jobs selected for comparison in this table. This is shown more fully in the following comparison in which the number of jobs of each class of materials is shown for each group as follows:

Low production and high time loss group No. of Jobs	High production and low time loss group No. of Jobs	Kind and Character of Material
2	1	Earth, good.
1	1	Earth with some well or fairly well blasted rock.
2	..	Earth with many boulders or with poorly blasted rock.
1	2	Well blasted rock and shale, some earth.
2	1	Fairly well blasted rock and shale.
1	3	Poorly blasted rock.

There is no evdence here that the jobs of the high-production group had any particular advantage as to materials. Of good earth the high-production jobs had only one job as compared with two good earth jobs for the low-production group. And while the low-produc-

TABLE X.—PRODUCTION RATES AND OPERATING CONDITION ON 51 GRADING JOBS

Project No.	Size of dipper,[1] Cubic yards	Average yardage per dipper load, Cubic yards	Production— Total Cubic yards	Production— Rate per hour, Cubic yards	Total net working time, Hours	Time Losses— Major Per cent	Time Losses— Minor Per cent	Kind and Character of Material as Affecting Rate of Shovel Operation
1	1¼	0.70	13,344	58.8	227.45	28.7	30.7	Earth, mostly shallow cuts, some rock.
2	1¼	0.52	13,358	48.5	275.44	29.7	31.3	Earth, mostly shallow cuts, some rock.
3	¾S	0.55	5,204	53.2	98.30	34.4	45.1	Red clay, schist and sandstone, F. W. B.
4	⅞	0.61	17,827	71.5	249.25	30.4	29.3	Red clay, some soft rock.
5	1	0.65	23,787	90.2	263.75	26.7	33.3	Red clay, schist and sandstone, F. W. B.
6	1¼	0.73	7,466	62.5	119.25	35.2	36.2	Laminated sandstone tilted, difficult.
7	1½	1.09	28,028	113.0	248.23	64.4	32.5	Sandstone, schist earth and hard pan, F. W. B.
8	1¼	0.86	5,834	105.0	55.50	13.3	22.2	Sandstone fairly well blasted.
9	1½	1.10	43,458	133.0	326.44	58.8	27.1	Sandstone and schists, F. W. B.
10	1	0.72	11,330	70.8	160.07	24.0	31.8	Earth and some limestone.
11	1¼	0.83	10,520	83.1	126.36	39.5	28.4	Clay with large limestone boulders.
12	1¼	0.50	31,702	47.2	672.45	27.1	33.9	Limestone, poorly blasted.
13	1¼	0.68	19,300	64.5	299.34	10.2	31.9	Sandstone, fairly well blasted.
14	1½	*0.75	70.500	67.9	1039.24	16.8	33.5	Shaly clay and limestone, F. W. B.
15	1¼	0.76	25,950	71.0	365.90	34.7	24.7	Decomposed granite fairly well blasted.
16	1¼	0.90	27,835	105.7	263.40	34.1	33.2	Decomposed granite fairly well blasted.
17	1½	0.98	52.400	100.5	520.77	33.5	24.1	Decomposed granite poorly blasted.
18	1	0.60	15,500	93.3	166.46	30.7	28.4	Mostly rock, ⅓ casting, F. W. B.
19	1½	0.62	17,000	79.3	214.28	34.8	24.9	Mostly rock, ⅓ casting, poorly blasted.
20	1¼	0.79	62,635	127.6	490.18	5.8	22.1	Sandstone and shale, fairly well blasted.
21	1¼	0.88	50,392	150.3	334.92	11.0	23.3	Sandstone and shale, fairly well blasted.
22	1¼	0.79	18,885	80.2	233.58	60.0	26.2	Clay-gravel and large boulders, slow shovel.
23	1¼	0.86	21,135	73.8	286.64	50.1	37.6	Sand-clay gravel, schist.
24	1¼	0.75	22,652	73.6	307.61	49.5	33.4	Clay-gravel, boulders, schist.
25	1½	0.89	10,963	81.6	134.51	20.0	39.6	Fairly well blasted granite, much finishing.
26	1	0.64	16,236	70.4	230.62	10.0	34.1	Rock, fairly well blasted and talus.
27	1¼	0.84	28,400	78.8	360.27	15.1	39.4	Rock, fairly well blasted, talus and earth.
28	1¼	0.68	5,987	42.8	139.98	33.9	53.9	Shallow cuts, many boulders.
29	1¼	0.61	2,752	37.1	74.35	15.5	36.5	Poorly blasted, hard granite.
30	1¼	0.88	9,029	71.5	126.43	21.0	42.3	Earth and poorly blasted granite.
31	1	0.73	10,125	61.2	165.47	20.8	37.9	Blue sandstone and shale well blasted.
32	1¼	0.86	4,927	44.3	111.30	7.2	55.1	Rock, some earth and boulders, poorly blasted.
33	1¼	0.92	54,847	83.0	661.00	25.0	33.0	Earth and some standstone and boulders.
34	1	0.41	14,815	37.2	397.96	26.6	34.2	Clay and limestone strata, poorly blasted.
35	1¼	0.99	20,310	125.5	161.82	33.2	30.6	Clay and stratified limestone with clay seams.
36	1¼	1.01	7,780	150.5	51.35	17.1	20.9	Good clay, few boulders.
37	1¼	0.88	8,036	125.0	64.12	8.4	25.0	Earth, well blasted soft rock, some frost.
38	1¼	1.00	18,060	133.2	135.70	6.1	25.1	Earth, well blasted soft rock, some frost.
39	1¼	0.99	14,700	114.9	128.12	11.0	34.4	Earth, some frost.
40	1	0.75	55,415	62.3	891.39	25.6	34.7	Earth, some rock well blasted.
41	1	0.75	16,800	70.3	239.19	24.5	37.2	⅓ rock and ⅔ earth, rock poorly blasted.
42	1¼	0.75	7,210	61.6	117.00	31.2	48.5	Earth, good.
43	1	0.76	6,885	68.5	100.40	38.0	55.7	Earth, good.
44	1¼	0.81	4,680	87.0	53.80	44.0	28.2	Fair to poorly blasted rock, pioneering.
45	2¼S	1.46	29,850	172.3	173.23	27.8	31.5	Fairly well blasted rock and shale.
46	2¼S	1.50	30,300	156.7	193.46	19.4	27.3	Fairly well blasted rock and shale.
47	2	1.00	5,750	98.3	58.40	39.1	30.9	Fair to poorly blasted rock, much clean up.
48	1½	0.80	44,900	56.6	793.97	25.4	46.2	Rock and slate, fairly well blasted, S. T.
49	1¾	0.93	2,074	72.0	28.79	36.0	42.0	Fairly well blasted rock, shovel slow.
50	1¾	1.22	8,690	99.0	87.82	12.2	27.4	Hard shale—inexperienced operator.
51	1¼	0.51	2,138	41.3	51.65	6.1	39.6	Poorly blasted rock stratified dipping away from shovel.
Totals and averages	1.30	0.82	1,061,702	81.3	13,053.44	30.4	33.2	

Notes: [1]Manufacturer's rating of capacity of dipper.
*Other factors than size of normal dipper load affected average production rate.
F. W. B. designates fairly well blasted materials; S. T., small trucks; S, steam shovel.

tion jobs had two jobs in earth carrying many boulders or poorly blasted rocks as compared with no such jobs for the other group, this would seem to be more than fully balanced by the fact that the high-production group had three jobs in poorly blasted rock as against only one shovel in such material for the low-production group. It would thus appear that if any real difference existed in the ease with which the materials of the two groups could be handled, the high-production jobs probably had on the average somewhat the most difficult materials to handle.

We do note further in Table I that the average shovel cycle for the high-production group was about 16 per cent shorter than the average shovel cycle for the low-production group. This, however, explains less than one-sixth of the difference actually found in the average production rates of the two groups. On one of the low-production jobs the shovel was slow and working conditions were poor. The effect of the slowness of the shovel on production rates, however, is properly accounted for in the length of the shovel cycle. Furthermore, it is well known that both the care and condition of the shovel are primary duties of the management. Working conditions are also, at least partly, subject to control by the management. The weight of all the evidence presented by these 17 selected jobs as well as that associated with the entire 51 jobs included in this study, therefore leads to the general conclusion that while many factors combine in various ways to influence the rate of production secured on any highway power shovel grading job, that of management appears to be the most common as well as the most important.

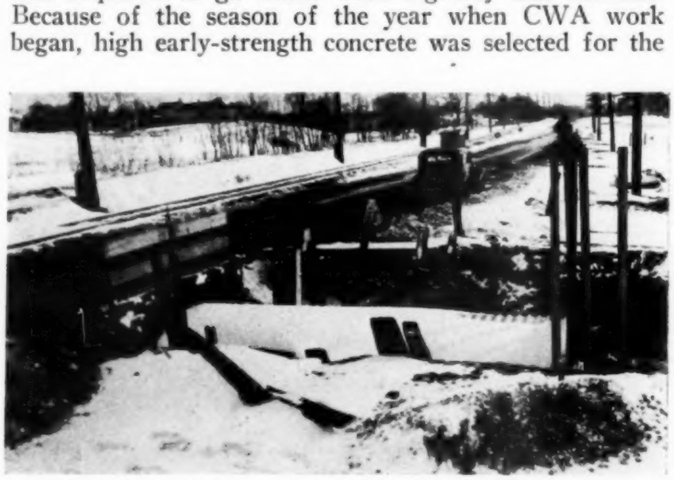
WINTER WEATHER NO HINDRANCE

to Construction of Important Culvert

WHEN the CWA was initiated with such suddenness as to tax the ingenuity of engineers everywhere in finding suitable projects, the state of Ohio was fortunate in having in Montgomery County a necessary project especially adapted to the purpose.

Near Miamisburg the old Miami and Erie Canal parallels State U. S. 25 (Dixie Highway) and the C. & L. E. (electric) R. R. Although no longer used as a medium of transportation, the canal serves as a drainage channel, receiving considerable runoff from surrounding rolling country. At a point where the canal elevation is slightly higher than the railroad and highway, the canal had broken through its banks on several occasions, washing away railroad ballast and flooding the highway. Public safety and convenience demanded that a culvert be installed under the railroad and highway to provide drainage to the Miami River some 200 yards away.

The structure selected for the purpose was an Armco multi plate arch. A span of 15 ft. and a rise of 5½ ft. was determined as the proper size; a length of 65 ft. was required to go under both highway and railroad. Because of the season of the year when CWA work began, high early-strength concrete was selected for the



Installing First (West) 25 Ft. of 65 Ft. Arch; 15 Ft. Span, 5 Plate, 3 Gage, 5 Ft. 6¼ In. Rise

Top: Constructing Forms for Downstream Headwalls; Next Illustration: General Construction View, Taken March 9, 1934. Next Illustration: Beginning to Excavate Under Railroad (Note Pavement and Gravelly Soil). Bottom: View Showing East End of First 20 Ft. of Arch; Before Construction Was Continued the Alternating 5 Ft. Plates Were Removed in Order to Give Staggered Joints

footings. And, as scour might reasonably be expected in the alluvial soil and gravel encountered, a full-width floor of the same kind of concrete was specified.

Job Quickly Started.—With the structure already designed for the purpose, it took but a few days to get a CWA project under way. Excavation for the outlet channel was begun at once while materials for the culvert were being delivered to the site.

Work on the culvert itself began at the outlet end. In order to permit at least one-way traffic over the highway at all times, the culvert was constructed in three installments—two under the highway and one under the railroad.

Maintenance of highway traffic was very important as U. S. 25, the Dixie Highway, between Cincinnati and Dayton is one of the most heavily traveled roads in the state. A detour would have involved tremendous inconvenience and expense to the traveling public. Railway traffic was maintained by supporting the track with I-beams during construction.

Unusually severe weather prevailed during most of the construction period. However, operations were rarely suspended entirely and then usually only because of heavy rain or snow. Concrete was poured when the temperature permitted, but there was enough other work —excavation, form building for footings and headwalls, erection of plates, and backfilling—to maintain more or less continuous operations. Arch plates were erected within 48 hours after pouring the early-strength concrete base and immediately backfilled with earth although salamanders placed under the arch protected the concrete (floor) from freezing for some time afterward.

Headwall Construction.—The outlet end of the arch was provided with a standard concrete wing-type headwall. At the inlet end due to the higher elevation of the canal bed, a drop inlet was constructed, likewise of concrete. Broken pieces of concrete removed from the old pavement at the site were used to rip rap the channel below the culvert.

With the exception of pavement restoration which was done by state maintenance forces after the backfill had been permitted to settle for about six weeks, all work was done during the CWA period with CWA labor. Engineering and supervision were provided by Division 8 of the Ohio State Highway Department.

▼

Completing Erection of First 20 Ft. and Backfilling; Bituminous Material Painted on Joints and Bolts

Top: Plates for Remaining 45 Ft. of Arch (Total Length 65 Ft.) Next Illustration: Riprapping Outlet End of Arch. Drop Inlet for Arch. Bottom: Outlet Ditch for Arch Under U. S. 25 Near Miamisburg, O.

PAVING WITHOUT PROPERTY ASSESSMENT

EVANSVILLE, ILL., has discovered a practical and popular way to pave its main streets without property assessment — a method which has been successfully in operation since 1930.

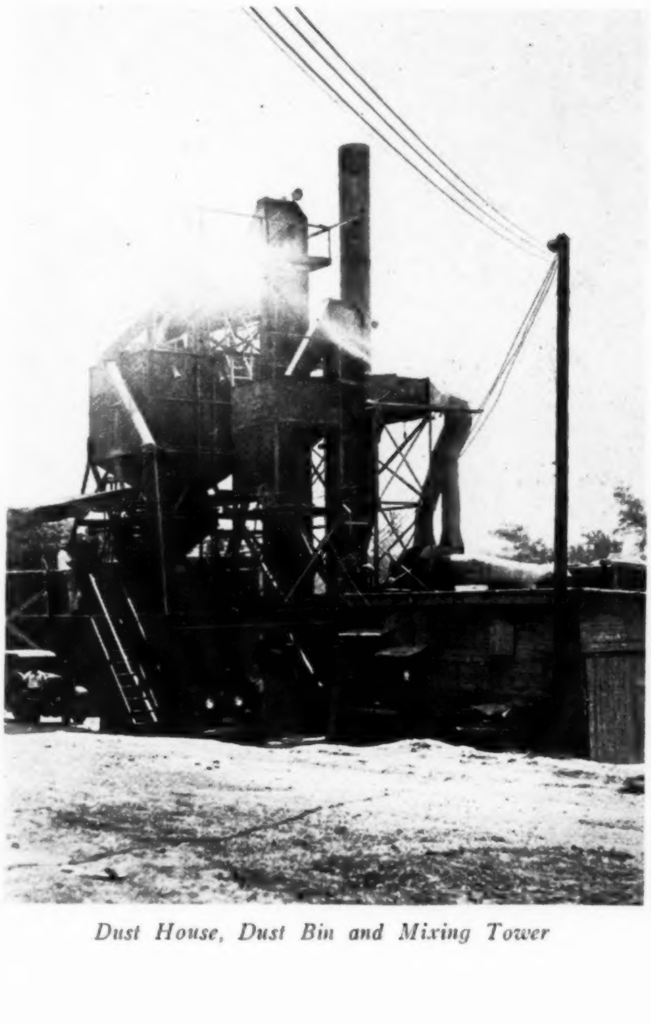
Since 1930 some paving has been done each summer, and plans call for a continuation of this work through 1937, when all main streets will have been paved. This work is financed by a special tax which was willingly approved by villagers with the understanding that all receipts would be used for new construction—and that when the main streets were paved the tax would be discontinued.

The streets being paved were of Telford stone. They had become so rough and unsatisfactory that something had to be done. When a way to finance had been agreed upon, various surfacing treatments were considered. In 1916 a section of the old street was rebuilt by spreading the stone from the old Telford surface over the subgrade. Cement grout was placed over this, getting a modified type of cement bound macadam pavement. This street has rendered service ever since at practically no cost. So, after full consideration, this was determined as the most economical treatment.

In 1933 the cost of paving in this manner was only $1.15 per square yard, paying local labor 30 cents per hour. And maintenance has been practically nothing on the completed work. Simply the cost of filling joints—and this is not necessary more frequently than every third year.

Hopper of Spreader

ASPHALTIC CONCRETE With Plant-Mix Spreader - - - -

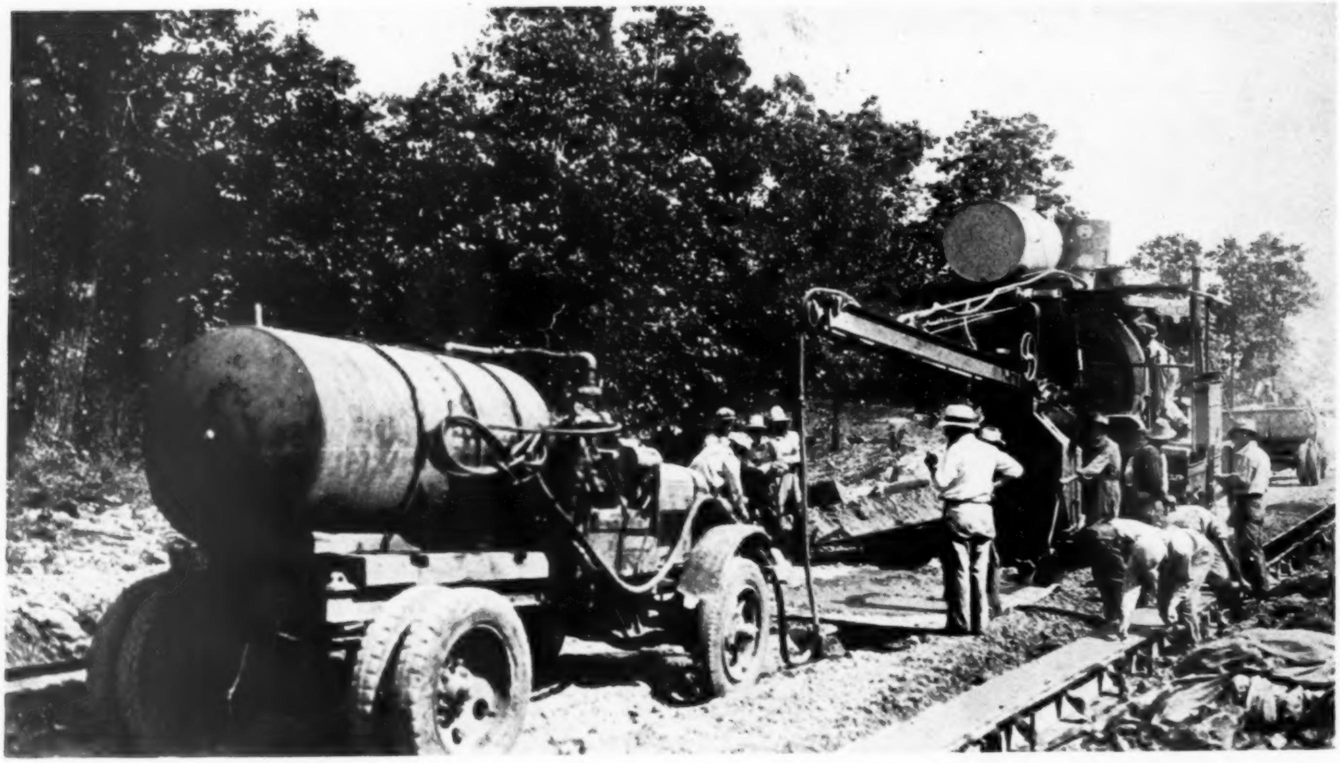


Dust House, Dust Bin and Mixing Tower

By SHELBY L. HEMAN
President Trinidad Asphalt Mfg. Co., St. Louis, Mo.

AT the beginning of work on our contract for constructing 10 miles of asphaltic concrete pavement out of Potosi toward DeSoto, Mo., for the Missouri State Highway Commission under Projects 375F, 375G, and 31 NRH, we were confronted with several problems. Chief of these was the securing of a spreading and finishing machine that would be capable of handling the large tonnage of bituminous material we expected to produce. Another problem was the devising of some method of pouring concrete for the 1 ft. protection curb that would obviate the necessity of laying a pipe line the entire length of the project.

How the Water Supply Was Secured.—In the latter case, this difficulty was overcome by placing an auxiliary water tank on top of a 27E Koehring paver. This tank holds 600 gal. of water. To feed the water to the mxier and also for all day curing with water and burlap, which is required, two Hug trucks were utilized by placing on them two 600 gal. water tanks, with a 2 in. Sterling pump on each. The piping was so arranged that by closing of valves, water could either be pumped from an adjacent creek into the tank, or from the tank into the mixer, or from the tank to hose equipped with sprayer for curing concrete.



Water Wagon Pumping to Mixer; Note Hose Leading from Boom. Average Run of Curb About 3,000 Lin. Ft. Per Day

The curing of concrete and also the oiling of forms was accomplished by use of an air compressor mounted on a Ford chasis, the air being utilized to atomize both the oil spray and the silica of soda spray.

The spreading of the bituminous material was accomplished by the use of an Adnun spreader, which at all times was able to handle all material sent to it, and left as near a perfect job as possible to obtain. The maximum tonnage handled by this spreader was 792 tons in approximately 13 hours' run.

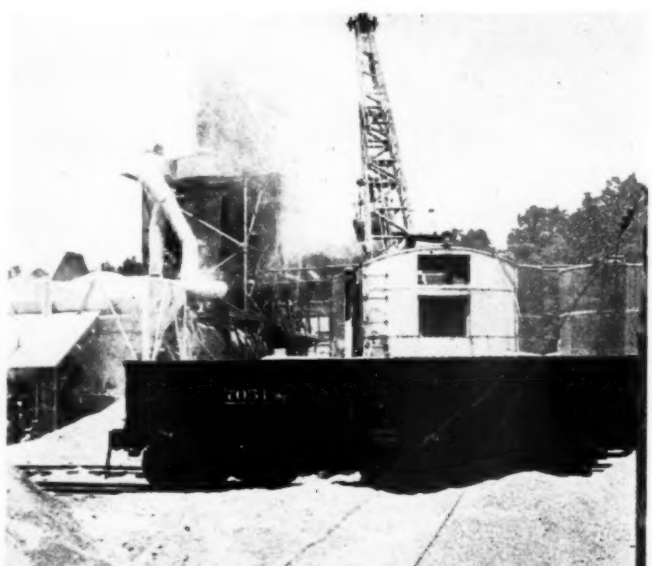
The Plant Layout.—The size of the contract (it required approximately 30,000 tons of bituminous material) warranted the creation of an elaborate plant layout. The mixing tower of the plant was furnished by Hetherington & Berner, Inc., of Indianapolis, Ind. The mixer itself is a 3,500 lb. unit. The tower is a semi-portable affair. The dryers of the plant are two Warren Bros. 24 ft. dryers. The feeding of the plant is accomplished with the use of a 50 ft. boom, 1¼ yd. clamshell Ohio locomotive crane. The aggregates are fed to the dryers through Butler bins, equipped with mechanical feeders. The bins are divided into three compartments, each compartment feeding separately. The three compartments were necessary in order to secure proper gradation.

Our plant layout is such that we have been able to handle five different kinds of aggregate to the dryers, with the necessity of rehandling only one kind of aggregate.

We have two 10,000 gal. vertical tanks for storage of asphalt. These tanks, as well as the hot aggregate bins, are equipped with thermo-couples attached to a recording pyrometer, as required by state specifications. The dryers are also equipped with an indicating pyrometer, giving us as near an absolute control of heat as possible.

This plant is also equipped with two 3 in. Kinney asphalt pumps, one for unloading and the other pump for circulation and feeding to the mixer.

The asphalt is weighed in a steam jacketed bucket with bottom discharge. The bottom discharge of the bucket obviates the necessity of either moving or touching the bucket. It is suspended directly above the mixer. The



Cold End of Plant

weighing of the asphalt, as well as the hot aggregate, is done with Fairbanks-More suspension scales, equipped with approximately 2 ft. dial heads.

The plant boiler is a 100 h.p. Erie Economic, fired by a Black Servant Stocker. Over this stocker is erected a wooden bin capable of holding approximately five tons of coal. The coal is fed to the bin by use of the crane. This was necessitated by the fact we did not wish the coal to become mixed with any aggregate which happened to be near the boiler.

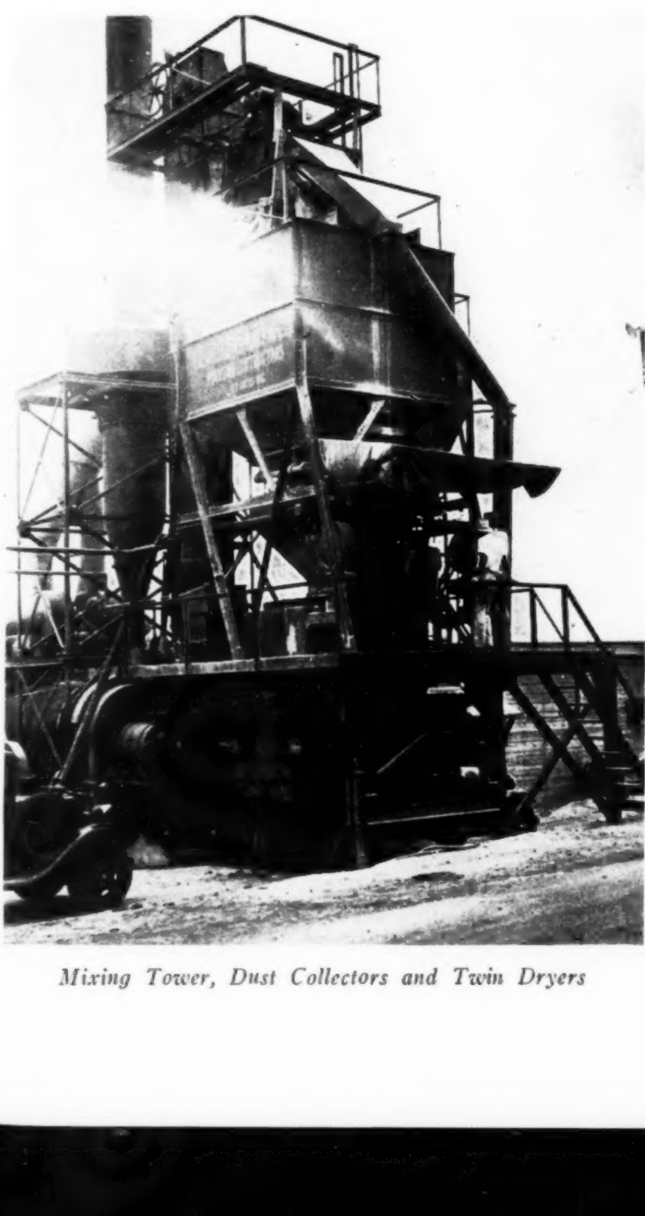
Nearly every unit of the plant is powered independently by use of motors and silent chains.

We have in all installed about 1,400 ft. of railroad siding. This track is a double track, one track being used solely for the crane and asphalt cars; the other track being used for storage of aggregates. The aggregate track will hold in all approximately 15 carloads of material.

New Pavement Construction.—About seven miles of the pavement is being laid over an old oil mat road. The new pavement is made to conform to the old oil mat with very little disturbance of it. This, of course, gives a variable depth to the paving, with a maximum depth of approximately 6½ in. and a minimum of approximately 5 in. laid in three courses. The first two courses consist of stone, all passing 1½ in. screen and the top consisting of approximately 60 per cent trap rock, all passing ½ in. screen.

Despite the variation of the subgrade, with the use of the spreading machine, we have been able to average the past several weeks approximately 550 tons per 12 hour day.

The rolling of the material is accomplished with one



Mixing Tower, Dust Collectors and Twin Dryers

3-wheel 10-ton Kelly-Springfield steam roller and one 10-ton Kelly-Springfield Tandem steam roller. The water for the rollers is furnished by a Hug truck equipped with tank, as mentioned above for supplying the concrete mixer.

The work is being done under the supervision of Mr.

Charging Spreader from Truck

Giles, Project Engineer. Much of the progress has been due to the splendid co-operation of the Missouri State Highway Department.

▼

Cost of Patrol Street Cleaning at Toronto, Ont.

The streets of all business sections of Toronto, Ont., receive a cleaning at least once a day, while congested areas receive constant cleaning. In addition to the regular daily cleaning by the patrolmen in the downtown section, all streets are flushed each alternate night. The following notes on the work are taken from the recently issued 1933 report of the Toronto Department of Street Cleaning.

Each patrolman has an average of 3 miles of streets to maintain, and during the summer of 1933, 113,073 cu. yd. of street sweepings were removed, averaging 12 cu. yd. per 1,000 sq. yd. of roadway per season. A daily average of 44 4-yd. wagons and 3 motor trucks were required in the pick-up service, while 187 patrolmen were engaged from April to December. The unit cost of hand-broom sweeping of improved roadways for 1933 was as follows:

Total cost (foremen, labor, cartage, supplies)	$241,912.63
Area of improved street mileage (sq. yd.)	9,211,319
Cost of maintenance per 1,000 sq. yd. per season	$26.27
Amount of sweepings collected (cu. yd.)	113,073
Cost per cu. yd. (sweeping, collecting and removing)	$2.14
Cubic yards removed per 1,000 sq. yd. per season	12
Number of patrolmen	187
Average area maintained per patrolman (sq. yd.)	49,000
Average number of times swept per season	90
Cost of sweeping per 1,000 sq. yd. (sweeping, collecting and removing)	$0.30
Cost of sweeping per mile	$4.46
Number of streets in the city	1,813

Patrolmen received $30 per week.

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One Way of Naming Streets—When Pekin, Ill., was settled the men named the streets of the new town after their wives. Some time later a letter was sent from New York City addressed simply: "120 Ann Eliza Street." Postal clerks knew of the manner of naming streets in Pekin and the letter was safely delivered.

INSPECTION AND TREATMENT OF CREOSOTED MATERIALS

By E. R. SNODGRASS
Manager, Colorado Plant, National Lumber and Creosoting Co., Salida, Colo.

and T. R. ELLIS
Assistant Materials Engineer, Colorado State Highway Department

IN the United States the use of creosoted materials dates back to 1860. At that time there were three treating plants in operation. The materials treated consisted almost exclusively of crossties and bridge timbers for railroads. The use of creosoted materials was formally introduced in the Rocky Mountain section in 1902 when the Southern Pacific Railroad built a treating plant at Alamogordo, N. M. In 1908 the Santa Fe Railroad built a plant at Albuquerque, N. M., and this was followed by plant of the Union Pacific Railroad at Laramie, Wyo. As these railroad plants treated exclusively for themselves, there was need of a commercial plant in this region. In 1925 one was built in Salida, Colo., and in 1928, another in Denver.

Inspection and Treatment.—On arriving at the plant the lumber or piling is loaded on tram cars by hand or by locomotive crane depending on the size of the timber. At this time the first inspection is made. Each piece of lumber is inspected for rot, large knots, checks, density of the grain and boxed-heart pieces. Piling is inspected for rot, checks, excessive bark, density of the grain and spiral-grain.

Defects.—Rot is the nemesis of all wood. It attacks standing trees, felled trees, and untreated lumber. It is a fungus requiring air, moisture, heat and food. It feeds on the mineral substances contained in the wood-cells until the lignose, of which they are composed, is reconverted into cellulose, destroying the timbers. As it would be impossible to remove the supply of air, moisture and heat, its source of food is the only logical necessity to be destroyed and this is done by rendering it unfit by treatment. While the growth of rot-fungus is inhibited by creosote treatment, the extent of its destruction cannot usually be predetermined. For this reason, pieces showing any signs of decay are rejected.

Checks, unless due to mechanical injury, are caused by seasoning. When a tree is felled, it naturally contains a high percentage of water and sap. In tests made on green Douglas fir piling the authors have found moisture contents as high as 60 per cent. When seasoning takes place, the moisture evaporates and the timber shrinks. Since this shrinkage is not uniform on all four sides of any piece of lumber, nor around the periphery of a pile, stresses are set up within the stick. These stresses cause the wood-fibres to separate at the points of greatest stress, causing cracks or checks in the wood.

While on the subject of checks it should be stated that checking in timber is a natural phenomenon. When seasoning some pieces will develop numerous hair-line checks while others may have only one opening. It can readily be seen that where shrinkage takes place cracks are bound to appear and if not too deep they are in no way injurious to the strength of the timber.

It is obvious that for economical reasons clear lumber can not be specified for bridges and other rough structures, consequently instead of eliminating knots, they are limited to a size that will not materially weaken any piece in which they occur.

Density of the grain is measured on the annular growth rings appearing in the ends of the piece. Most specifications call for close grained lumber, which means "there shall not be less than six nor more than twenty annual rings to the inch, averaged over three inches." The limitations on the density of the grain insure a piece of lumber or piling from a tree of uniform growth, which is a factor in the controlling of checking and warping.

Cross-grain or sloping grain is found in lumber cut from a tree that has twisted while growing. Such pieces will show a slanting-grain and if this slope, when measured in the center two-thirds or three-fourths of the stick, is more than 1 in. in 12 in., the piece is considered structurally unsound. This specification deals chiefly with pieces specified for use as caps and stringers, and others that will act under compression.

Boxed-heart timbers are those pieces containing the pith in both ends. These pieces are not weaker than those cut outside the heart but they tend to check to a much greater extent.

Sweep or bend in a pile must not be excessive enough to throw an imaginary line from the center of the butt to the center of the tip outside the body of the pile more than one per cent of its length.

Spiral grain in piling must not exceed one complete twist in a length of 40 ft.

Excessive bark on piling is not conducive to deep penetration of the creosote. There should be at least 1 in. separating any two pieces of bark whose dimensions exceed ½ in. in width and 10 in. in length otherwise the pile must be peeled.

Preliminary Treatment.—When a complete load or charge of inspected material has been obtained, the tram cars are made up into a train and moved to the treating retort which is a horizontal steel cylinder, varying in different plants from 6 ft. to 9½ ft. in diameter and from 90 ft. to 165 ft. in length. It is closed at one end and has a heavy hinged door at the other. On the in-

side, at the bottom, are steam heating coils and a track on which the trams containing the lumber are run. The cylinders are usually enclosed in a building which also houses a boiler plant and various pumps, compressors, valves, and instrument boards. Outside the building are working tanks containing the creosote oil. These tanks are equipped with volume gages and are connected to the retorts by pipelines.

The treating cylinder is charged, the door closed and the material is now ready for seasoning before impregnation.

While it is generally conceded that well regulated air-seasoning is more satisfactory, this takes from three to six months so the seasoning will be done artificially by the Boulton process. In this process the cylinder is nearly filled with creosote leaving only a small space at the top in which to collect the vapors. After the fill is completed, the oil line is shut off and a vacuum of 22 in. is pulled. During the vacuum period, the temperature of the oil in the retort is held at 185° F. to 190° F. As the lumber is heated, water and sap are brought to a boiling point and on vaporizing they are pulled through the vacuum line to the condenser where as condensate they are collected and measured in either pounds or gallons.

The creosote itself does not vaporize during this process as its boiling point is much higher than that of water. The seasoning is carried on until the volume of condensate carried over reaches one-tenth of one pound of water per cubic foot of timber per hour, when the vacuum is killed and the creosote is pumped back to the working tank.

The time required for seasoning varies with the moisture content of the wood. The ordinary length of time required for seasoning a charge of piling is from 20 to 80 hours although some charges require 100 hours.

A second seasoning process called steaming is commonly used on green southern yellow pine. Timbers are placed in the cylinder as before and live steam is turned on until a pressure of about 20 lb. per square inch is reached. This pressure is then maintained for several hours and the temperature of the wood reaches approximately that of a steam bath, which is about 260° F. The steam is then released to the atmosphere and a quick vacuum is applied to the cylinder. The heat stored in the wood by the steam bath causes the evaporation of sufficient moisture to permit satisfactory penetration of the creosote.

We do not believe that steam seasoning is as satisfactory as Boultonizing, because many kinds of wood are injured by high temperatures, however, if it can be used it will give satisfactory results. Usually ten or twelve hours is sufficient for steam seasoning.

Creosoting.—The treating process follows seasoning. The aim in treating is to obtain the deepest possible penetration of the creosote into the wood. This does not mean that a maximum amount of creosote is left in the wood. The creosote that is left in the wood depends on the amount required to give satisfactory penetration and the amount which will give satisfactory preservative life. These quantities vary with the climatic conditions under which the treated material is to be used.

The Reuping process is called for by the Colorado State Highway Department specifications. These specifications state that a minimum of 12 lb. of creosote oil per cubic foot of lumber must be injected into the wood and that, at least, 8 lb. of the 12 lb. must be retained. All outlets to the cylinder are closed and an air pressure of 25 lb. to 100 lb. per square inch is built up in the cylinder. The exact amount of air pressure is a matter of judgment. The operator next pumps creosote oil into the cylinder against the air and at the same time allows the air to escape without reducing the pressure. All outlets are then closed and additional oil from the working tank is pumped into the cylinder and forced into the timber.

During the pressure period, the temperature of the oil is held between 185° F. and 200° F. and at a pressure varying from 100 to 125 lb. per square inch. Pumping is continued until the gage on the working tank shows that at least 12 lb. of oil per cubic foot of lumber has been pressed into the wood. The pressure is then killed, the oil pumped back to the working tank and a vacuum of not less than 20 in. is pulled. During the vacuum period, the air which was trapped in the wood-cells will expand, forcing out all excess oil, thereby reducing the amount of oil retained without decreasing the depth of the penetration.

On completion of the vacuum oil which has dripped to the bottom of the cylinder is picked up by pumps and returned to the working tank. The net or final retention is calculated as the difference between the start and finish readings as shown by the working tank gages. The retention must be at least 8 lb. of oil per cubic foot of lumber.

The aim of the Reuping process is to obtain the largest practicable gross injection and to regulate the initial air pressure used so as to obtain the specified final retention.

Other Processes.—The Lowry and the Bethell processes are also used and will be described briefly.

The Lowry process is much the same as the Reuping. Both are known as empty-cell processes; the only difference being that in the Lowry process, initial air under pressure is omitted, and only air which is contained in the wood at atmospheric pressure is used.

The Bethell, or full-cell process, differs quite radically from the Lowry and Reuping processes in one respect. Instead of building up an initial air pressure, this method creates an initial vacuum thereby partially emptying the wood cells of air. The vacuum is maintained during the introduction of the oil into the retort. Aside from this the Bethell process follows the same procedure as the other two methods except the final vacuum is sometimes omitted. This process permits higher final retentions than either of the others; retentions of as much as 24 lb. of oil per cubic foot of timber are obtained.

In the Reuping and Lowry processes, the quantity of oil which is finally retained in the lumber is from 25 per cent to 50 per cent less than the amount initially injected into it, while in the Bethell process, there is practically no difference between the gross injection and the final retention.

The empty-cell processes leave the cells of wood only partially filled with creosote but the cell walls and firbres are thoroughly impregnated while the full-cell process leaves the lumber soaked and soggy with oil.

Final Inspection.—After treatment the lumber is inspected for depth of penetration of creosote and for any defects which were not apparent in the green lumber, but which are discernible after seasoning and treating.

Penetration is ascertained by borings taken with an increment borer which is an instrument with a hollow bit constructed so that it will extract a small core. The depth of penetration is measured on this core.

Defects are noted. These include checks and warping which sometimes occur if the seasoning process is carried on too vigorously and at excessive temperatures and cross-graining, which usually shows up quite distinctly after treatment, as do burst-checks and V-shaped checks.

Burst checks and V-checks were not mentioned in the discussion of defects in green timber because they are

generally caused from seasoning. A burst-check which is found in the ends of a timber is a circular check which follows the periphery of an annual ring. Intersecting this circumferential check is one from the outer face of the timber which gives the appearance of bursting. V-checks are slash-like openings found in the end of a stick and are due to the high temperatures to which the wood is subjected during the Boulton seasoning. At the time of contact of the wet wood and the hot oil, the outer faces start to expand. This expansion is due to thermal expansion and to swelling caused by increased fibre saturation. As the expansion of the outer faces is more rapid than in the inner portion of the stick, tensile stresses are set up in the center and as the outer faces pull away from each other, radial checks appear in the ends of the piece. This action is called tangential expansion.

Due to the fact that the periphery has become permanently enlarged, either by increased absorption of the cell walls, or to a permanent readjustment of the cell wall structure, or to both, and to the fact that the inner portion of the stick has not been subjected to the same high temperatures as the outer faces, the inner portion contracts on cooling and pulls away from the permanently enlarged periphery thereby causing checks which are commonly known as burst-checks.

Acceptable material is shipped to the project after final inspection.

Conclusion.—Correct temperatures should be maintained during the treating process. Low temperatures will not give satisfactory treatment and high temperatures injure the wood. A pressure that is too low will not force the oil into the wood, and high pressures will collapse the wood and compress the fibres so that they will partially exclude the oil.

The question may be raised as to why sap-wood must be fully impregnated and heart-wood only to a minimum of ½ in. This is because the sap-wood, while sound and strong, is still immature wood and as such is less resistant to decay than the heart-wood, which is fully matured and is more or less invulnerable.

Many people think that creosote is a water-proofing material. Creosote has no water-proofing qualities; its ability to preserve is due to its toxic and antiseptic qualities, which poison the wood so as to make it undesirable for food for the rot-fungus.

Different plants will have various types of equipment, and while processes of treatment are fundamentally the same, they may vary slightly and their ultimate results are comparable.

Lumber and piling must be properly seasoned. This means that all excess moisture must be taken out in order that the penetration of the creosote will not be retarded and checking below the treated area will not occur. Timber should be impregnated with a preservative which will ward off decay and which will not leech out. If these two requisites are met and the treated timber is given the same care in handling and construction as would be given to any other material, it will last indefinitely.

Acknowledgment.—The foregoing is an abstract of a paper presented at the 1934 Highway Conference at the University of Colorado.

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$200,000,000 Highway Fund Apportioned to the States

Acting Secretary of Agriculture Tugwell on June 19 apportioned $200,000,000 among the 48 states, Hawaii and the District of Columbia, for highway construction. The appropriation was authorized by the Hayden-Cartwright Act, signed June 18 by President Roosevelt for highway construction under the provisions of the National Industrial Recovery Act. Following the requirements of the law, the Acting Secretary apportioned seven-eights of the total authorization on the basis provided by the Federal Highway Act which prescribes three factors of equal weight based upon the area, population, and rural postroad mileage of the several states and Hawaii. The remaining one-eighth, as provided by law, was apportioned according to population.

The money is immediately available for allotment to construction projects on the Federal aid highway system and its extensions into and through cities and on important secondary roads. The law requires that, in the absence of satisfactory reasons to the contrary, not less than 25 per cent of the apportionment to any state must be applied to secondary or feeder roads, including farm-to-market roads, rural free delivery roads, and public school bus roads.

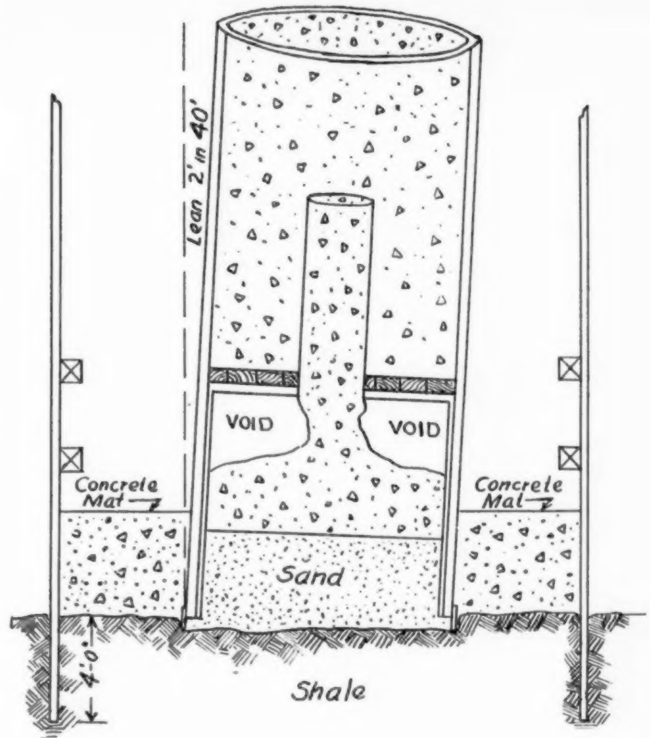
Expenditure of the money will be in accordance with rules and regulations to be issued by the Secretary of Agriculture.

The amounts apportioned to each state, Hawaii, and the District of Columbia follow:

	Sums Apportioned		
	Seven-Eighths According to Sec. 21 of the Fed. Hwy. Act	One-Eighth According to Population	Total Apportionment
Alabama	$ 3,722,613	$ 537,229	$ 4,259,842
Arizona	2,553,507	88,428	2,641,935
Arkansas	3,051,561	376,488	3,428,049
California	6,779,637	1,152,569	7,932,206
Colorado	3,275,724	210,282	3,486,006
Connecticut	1,128,642	326,226	1,454,868
Delaware	875,000	48,395	923,305
Florida	2,363,274	298,069	2,661,343
Georgia	4,523,020	590.471	5,113,491
Idaho	2,187,138	90,348	2,277,486
Illinois	7,372,261	1,549,140	8,921,401
Indiana	4,431,497	657,466	5,088,963
Iowa	4,616,722	501,639	5,118,361
Kansas	4,735,803	381,872	5,117,675
Kentucky	3,287,509	530,802	3,818,311
Louisiana	2,537,276	426,656	2,963,932
Maine	1,549,697	161,889	1,711,586
Maryland	1,478.833	331,225	1,810,058
Massachusetts	2,487,737	862,737	3,350,474
Michigan	5,469,502	983,066	6,452,568
Minnesota	4,905,029	520,522	5.425,551
Mississippi	3,132,202	408,025	3,540,227
Missouri	5,436,923	736,817	6,173,740
Montana	3,660.592	109,142	3,769,734
Nebraska	3,684,616	279,748	3,964,364
Nevada	2,283,870	18,486	2,302,356
New Hampshire	875,000	94,462	969,462
New Jersey	2 400,426	820,453	3,220,879
New Mexico	2,855,760	85,940	2,941,700
New York	8,772,350	2,555,571	11,327,921
North Carolina	4.197,326	643,615	4.840,941
North Dakota	2,800,745	138,222	2,938,967
Ohio	6,515,630	1,349,382	7.865,012
Oklahoma	4.198,747	486,433	4,685,180
Oregon	2,904,181	193,633	3,097,814
Pennsylvania	7,635,476	1,955,312	9,590,788
Rhode Island	875,000	139,572	1,014,572
South Carolina	2,417,958	352,996	2,770,954
South Dakota	2.906,984	140,659	3,047,643
Tennessee	3.771,790	531,201	4,302.991
Texas	11,108,746	1,182,507	12,291,253
Utah	2,029,590	103,101	2,132,691
Vermont	875,000	73,007	984,007
Virginia	3 273,714	491,673	3,765,387
Washington	2,789,019	317.393	3,106,412
West Virginia	1,929,280	351,055	2,280,335
Wisconsin	4,345,174	596,663	4,941,837
Wyoming	2,241.919	45.793	2,287,712
Dis. of Columbia	875,000	98,842	973,842
Hawaii	875,000	74,778	949,778
Totals	$175,000,000	$25,000,000	$200,000,000

By HARRY ENGLANDER
Construction Engineer
Williston Park, Long Island, N. Y.

UNDERPINNING A Bridge Pier In the Open

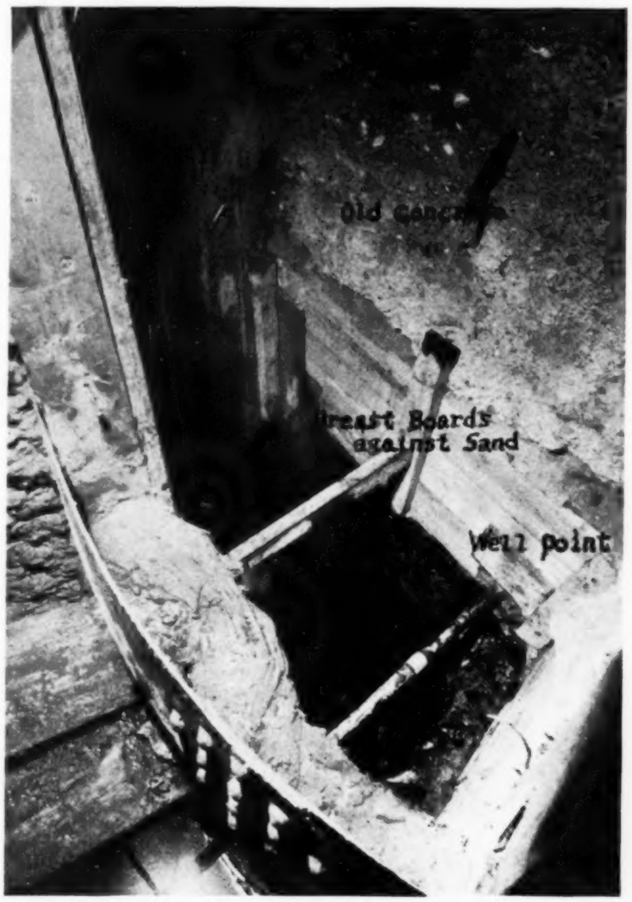


Sketch Showing Condition at Pier 2, Downstream Cylinder

THE underpinning of a bridge pier in the open, which had originally been built by the pneumatic method, was the interesting feature of this job.

The diversion of the channel at the side of the Index Bridge over the Red River at Texarkana, Ark., and the consequent deepening of the water around the piers originally on dry land, necessitated the construction of cutoff walls to guard against scour. The owners received a PWA grant and a contract was let to build a cutoff wall around three of the piers. These piers consisted of two 10 ft. cylinders carried to bedrock. Forty-five foot steel sheet piling toed 4 ft. into the bed rock formed the cofferdam. After excavating the cofferdam to bed rock, it was contemplated to build a cutoff wall 3 ft. wide and 8 ft. in the rock around the perimeter of the pier. This wall was to be carried to low water and the entire pier encased in concrete. Upon unwatering it was found that the downstream pier cylinder leaned 2 ft. in 40 ft. The working chamber was filled with poor concrete and contained voids near the deck, and also the cutting edge was not carried into the rock. The bed rock, consisting of a soft carbonaceous shale lying in horizontal strata, began to heave, and danger of the toe of the sheeting failing was possible. The bed rock was thoroughly cleaned off, and a 4 ft. concrete mat was poured over the entire bottom. Upon the recommendation of Alexander Allaire, PWA State Engineer for Arkansas, the writer was called in by the owners to devise means and supervise the underpinning of this pier.

Holes drilled through the mat, extending 8 to 10 ft. into the shale, located over the entire area, were grouted under pressure with neat cement, effectively sealing all crevices in the shale and reducing the pumping to a minimum. The upstream working chamber was found to be in satisfactory condition and the concrete satisfactory. Through adits on either side of the cylinder



Section 1 Excavated 5 Ft. Below Cutting Edge

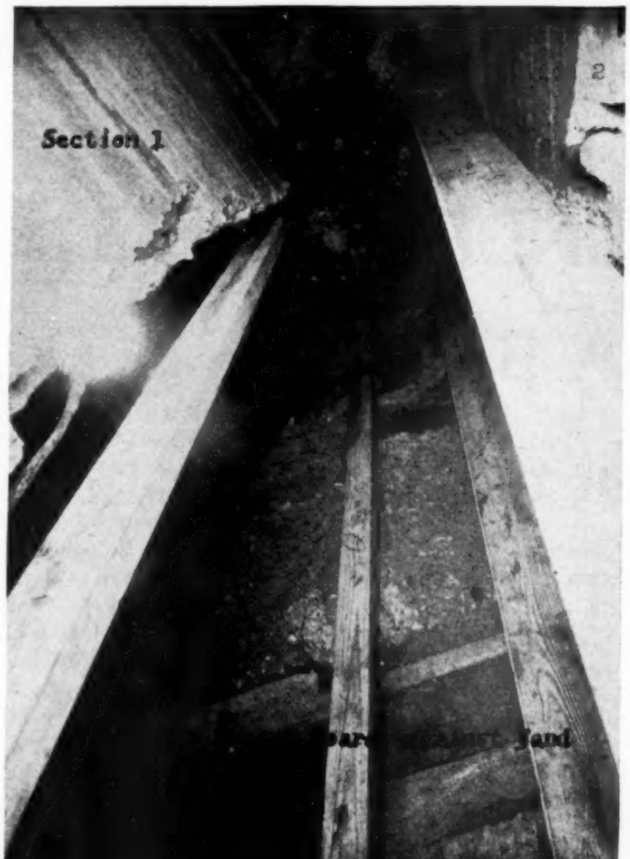
Shores Against Cylinder

drifts, 3 ft. wide and extending 5 ft. below the cutting edge, were excavated around the perimeter and filled with Incor cement. Pipes leading to the adits were concreted in and afterwards grout forced through them insured contact between the mat and the drift concrete.

The entire load on the downstream cylinder was about 480 tons. Eight 12 in. by 12 in. oak pushers were placed against the cylinder to take care of the load. These were on 50-ton screw jacks, the ends notched in the cylinder and the footing resting on the mat. An adit at the center line of the cylinder was excavated 5 ft. below the cutting edge. To dry up the fine liquid sand in the working chamber, 1¼ in. well point was driven horizontally under the cutting edge, and the water completely removed after 24 hours' pumping with a hand pitcher pump. The volume of the working chamber was removed in five sections, and the rock excavated 5 ft. below the cutting edge. As each section was completed it was filled to within 3 in. of the deck with Incor cement concrete. Four hours were allowed for set, and the 3 in. space drypacked against the deck, thus transferring the load to the new footing. To form a dumb-bell pier, a groove was cut at the center line of each cylinder, holes drilled for dowels and a 3 ft. wall poured between the cylinders.

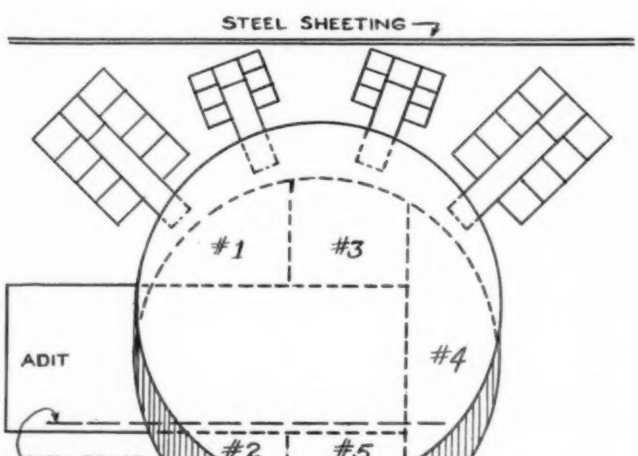
As the bridge was a toll bridge, traffic passed over it on a slow order. The work was carried on in 4 6-hour shifts, and rushed to completion on account of anticipated high water.

Mr. Alexander, PWA State Engineer, with L. D. Brown as Resident Engineer, covered the work for the PWA, J. W. Dawson of Texarkana was the engineer in charge for the Red River Bridge District, Kochitsky and Johnson were the contractors with D. Williams as superintendent. The writer supervised the underpinning of this pier.



Sections 1 and 2 Concreted and Drypacked

Shores Against Cylinder



Sketch Showing Location of Shores. Numbers Indicate Sequence of Removing Concrete in Working Chamber

GRADATION OF AGGREGATES FOR BITUMINOUS SURFACES

By J. N. DOHERTY
Research Engineer, North Dakota Department of State Highways, Bismarck, N. D.

THE advantage to be gained by properly grading the aggregate in portland cement concrete is so well known today that no structure of importance is built without exacting control of the aggregate.

When portland cement first came into general use little or no attention was paid to the grading of the aggregate. Pit run gravel with cement and water to suit the individual taste was the general practice and it was not until the engineer began to look into the subject and found that better and cheaper concrete could be made with a properly graded aggregate that the hit and miss practice began to die out. Extensive research was carried on and it was found that the properly graded aggregate gave a stronger, denser and cheaper concrete and, due to the density, a much more durable product, as it was freer from disintegrating action of frost and various chemicals in the soil. Just how far this grading of aggregate can be economically carried is now being studied. On some paving work in Wisconsin in 1931 the coarse aggregate was separated into three sizes and the batching of all grades was by weight. The results of Wisconsin's study will be watched with a great deal of iterest.

Another outstanding study of the effect of a properly graded aggregate is found in the asphalt industry. During the early days of the asphalt paving industry we find practice almost exactly paralleling the early portland cement practice. Any sand that looked good to the eye was considered satisfactory for a sheet asphalt pavement. This practice continued for several years. Then it was observed that there was a great difference in paving jobs. Some gave excellent service, some failed completely in a few years and some scarcely went through the first year without serious cracking and signs of early failure. The same asphalt had been used on the poor jobs as on the good jobs. The workmanship was apparently equal and records show that the asphalt had been properly handled and the rolling had been well done.

One of the leading asphalt paving companies retained Clifford Richardson, a consulting engineer of New York, to make a study and a report on the causes of the trouble in the asphalt paving industry. His study was comprehensive. He took numerous samples from both the poor jobs and the good jobs and the detailed results of his study are to be found in his book, "The Modern Asphalt Pavement." His study showed that poor grading was the cause of almost all of the failures. Every good job showed a well graded aggregate. Every unsatisfactory job showed a poorly graded aggregate, and the poorer the grading the earlier the failure. From that day to this, no properly supervised asphalt paving job has been built that did not give great attention to the grading of the aggregate. Engineers know that it pays and pays well.

Oil-Mixtures.—Today there is another type of road surfacing coming into general use in a large portion of the country, known as the oil-mix. In the practice of engineers in its construction, we find exactly as was the case in the portland cement and the asphalt paving industries, that there are those who think, that any old gravel is good enough and those who say, "No, for good results you must properly grade your aggregate. It will pay to do so." Road oil is not as stable a bitumen as is paving asphalt and in an open mix will be readily attacked by oxidation and water. The little booklet put out by the Asphalt Institute lists oil-gravel-mix as a graded aggregate type of surfacing, and says that the aggregate should be well graded from coarse to fine. To those who are familiar with what well graded means in portland cement work, or asphalt paving work, this statement is sufficient. They know how to get a well graded aggregate for portland cement concrete and they know how to get it for asphalt pavement, but many will be in charge of oil-mix construction who do not have the advantages of the broader background and "well graded" may not mean to them what it should.

The simplest way to analyze the grading of an aggregate is by plotting a grading curve. North Dakota uses a sheet with the size of screen as ordinates and percentage of total aggregate as abscissa. A logarithmic scale is used for screeen sizes and a uniform scale for the percentages passing.

Stability in the Aggregate.—The least stability in an aggregate occurs when the particles are all of the same size and rounded. A predominance of only one size in a gravel indicates lack of stability. Maximum stability occurs when there is a straight line grading, for then we have maximum density. By plotting a curve of the grading we can see at a glance whether or not there is a well graded aggregate. A predominance of any one size will show up plainly and at the same time we can see just what must be done to correct the grading. If more than one source of aggregate is available the best one can be seen at a glancee. The best grading will sometimes require the use of aggregate from more than one source or where a pit is variable in grading the best combination can be worked out. This can be done

usually at very nominal expense and should be done. If previous experience is worth anything all the indications are that it will pay well and the engineer who within economic limits, does not get maximum value out of all the products he works with is in just that measure falling down on his job.

The straight line grading has been pretty definitely determined as the ideal grading for a dense aggregate. This requires grading clear down to the 200-mesh material or lower. The survey of sheeet asphalt showed that better results were obtained when the filler contained the proper proportions of material even finer than 200-mesh. As screens can not be satisfactorily used below this size, these smaller fractions can best be determined by stirring the filler water and observing the time of settlement. To the layman, the addition of filler looks like putting in just so much dirt, but the engineer knows that this is just as essential as any part of the mixture, and it is not just dirt. It may be a silt but it must be of such a nature that it will mix readily and hold the bitumen. If it balls up in the mixing it should not be used as it is impossible to incorporate it uniformly into the mixture. There are fillers that mix readily but which will not hold the oil, especially in the presence of moisture. As this quality can be pre-determined, such a filler should not be used. The fineness and amount of filler to be used will depend on the grading of the sand fraction, especially on the 80 and 100-mesh screens. If the gravel is lacking in these sizes the filler should apply the deficient sizes.

There is a great deal of literature available on the subject of oil-gravel-mix, but it is found in engineering magazines. In the writer's opinion the importance of grading of the aggregate has not been given its proper consideration. Both logic and the previous experience of the portland cement and asphalt industries clearly point the way. It is not expensive and the analysis of the grading of a gravel is a simple matter. The grading should be corrected as much as possible within economical limits. Screening equipment for the removal of oversize will be required on nearly all jobs. The additional screen and bin equipment required is usually inexpensive and better results are sure to result from a well graded aggregate.

Acknowledgment.—The foregoing is a paper presented at the 1934 Highway Conference at the University of Colorado.

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Motor Vehicle Registration Declined Slightly in 1933

There were 23,827,290 motor vehicles registered in the United States in 1933, a decline of 1.2 per cent from the previous year, according to reports from state authorities to the Bureau of Public Roads, U. S. Department of Agriculture.

Passenger vehicles in 1933 numbered 20,600,543 as compared with 20,883,625 in the preceding year. Trucks totaled 3,226,747 as compared with 3,229,315 in 1932, a decrease of 0.8 per cent. There were 472,789 trailers registered in 1933 and 91,987 motorcycles.

Considering the trend of motor vehicle registration from the peak of 26,545,281 in 1930, the decline in total registered motor cars and trucks have been 2.8 per cent in 1931, 6.6 per cent in 1932, and 1.2 per cent in 1933. Truck registration also declined in 1931 and 1932.

The total motor vehicle registration by states for 1933 and the decline or increases from the previous year are as follows:

State	Total Vehicle Register in 1933	Changes in Registration from 1932 (Increases have no sign) Per Cent
Alabama	206,361	— 8.6
Arizona	89,496	— 5.7
Arkansas	188,242	37.8
California	1,958,807	— 0.8
Colorado	266,491	— 6.9
Connecticut	314,751	— 2.1
Delaware	51,099	— 2.4
Florida	279,265	— 2.4
Georgia	330,147	14.8
Idaho	96,255	0.2
Illinois	1,463,050	— 1.8
Indiana	770,071	— 3.4
Iowa	632,292	— 7.4
Kansas	517,987	2.6
Kentucky	294,547	1.1
Louisiana	232,688	— 2.6
Maine	168,173	— 1.9
Maryland	313,274	— 2.7
Massachusetts	789,788	— 1.4
Michigan	1,077,209	— 5.2
Minnesota	679,243	— 0.5
Mississippi	164,688	7.1
Missouri	698,362	— 2.7
Montana	110,245	1.0
Nebraska	390,651	4.2
Nevada	28,324	— 9.7
New Hampshire	107,631	2.3
New Jersey	845,734	— 1.1
New Mexico	76,643	— 0.3
New York	2,240,757	— 0 4
North Carolina	382,308	1.6
North Dakota	153,889	0.4
Ohio	1,554,314	— 2.2
Oklahoma	451,712	8.7
Oregon	239,410	— 7.5
Pennsylvania	1,635,019	— 1.8
Rhode Island	136,261	2.1
South Carolina	162,735	— 7.7
South Dakota	169,249	4.4
Tennessee	312,180	4.5
Texas	1,201,762	0.4
Utah	100,362	3.2
Vermont	73,576	— 5.0
Virginia	344,704	— 8 4
Washington	427,406	— 4.0
West Virginia	226,985	0.8
Wisconsin	670,797	— 3.6
Wyoming	52,560	— 6.5
District of Columbia	149,790	— 7.1
Total	23,827,290	— 1.2

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Simplified Practice Recommendation Covering Vitrified Paving Brick Reaffirmed

Simplified practice recommendation R1-32, covering vitrified paving brick, has been reaffirmed, without change, as of June 15, 1934, by the Standing Committee of the industry, in charge of the periodic review of this program, according to an announcement by the division of simplified practice, of the National Bureau of Standards.

This recommendation, which was first proposed and developed by the industry in 1921, has, since that time, been reviewed annually, and revised 7 times. In its recent survey, the committee found that 91.5 per cent of the total shipments during the calendar year 1933 were in accordance with the 6 sizes shown in the Simplified Practice Recommendation.

In 1921 vitrified paving brick was available in 66 different sizes. The original recommendation reduced this variety to 11, and the first revision conference further reduced the number to 7 sizes. Subsequent conferences and surveys have resulted in a net reduction to 6 sizes.

Copies of this recommendation may be secured from the Superintendent of Documents, Government Printing Office, Washington, D. C., for 5 ct. each.

P. W. A. REQUIREMENTS

For Construction of Non-Federal Projects

INSTRUCTIONS regarding the construction of any non-Federal public works project financed under the National Industrial Recovery Act are given in Bulletin No. 2 issued by the Federal Emergency Administration of Public Works, Harold L. Ickes, Administrator. This bulletin, which was revised March 3, 1934, contains the PWA requirements as to bids, contractors' bonds, and contract, wages, and labor provisions and general instruction as to application, loans and grants. The bulletin is reprinted herewith.

INSTRUCTIONS FOR THE GUIDANCE OF STATE ENGINEERS (PWA)

I. REQUIREMENTS OF THE ADMINISTRATION
A. BIDS AND AWARDS

1. The rules and regulations of the Administrator contemplate that bids be received and contracts let to the lowest responsible bidder for the construction of any public works project financed under the National Industrial Recovery Act. Any deviation from this practice other than as provided by paragraph 5 hereof shall have the prior approval of the Administrator.

2. Advertisements for bids, and the complete contract plans and specifications upon which the contract is to be let, shall be approved by the State engineer prior to the advertisement for bids.

3. Before a contract is awarded for any project, bids shall be requested by advertisements inserted once a week for 2 weeks in such newspapers and/or other publications as will insure adequate publicity, the second insertion of such advertisement to follow 1 week after the date of the first publication thereof. The advertisement shall require bids to be submitted and opened 2 weeks after the date of the first publication of the advertisement, and award to the lowest responsible bidder shall be made promptly after the opening of bids. This procedure may be varied by the State engineer (PWA) if he deems such variation desirable in order to expedite projects.

In the event that local statutes impose different conditions in respect to the advertising of contracts and the like, such local requirements must of course be followed.

4. Under U. S. Government Form No. PWA 61, revised (March 1934), no bids will be received from any contractor who has not complied with the applicable approved code of fair competition adopted under title I of the National Industrial Recovery Act for the trade or industry or subdivision thereof concerned, or, if there be no such approved code of fair competition, who has not signed and complied with the provisions of the President's Reemployment Agreement.

5. The politics of the bidder shall have no influence whatever on the awarding of the contract. No contracts will be awarded until bids have been examined and passed upon by the State engineer (PWA), who will satisfy himself that the bidders are capable of carrying on the work bid upon and that the contract is awarded to the lowest responsible bidder: Provided, however, That in the selection of materials and/or equipment the applicant may, in the interests of standardization and/or ultimate economy, make recommendation and present basis for choosing or selecting other than cheapest in price, and the State engineer may approve in writing such selection if he deems it a proper economy; Provided further, That any action taken hereunder does not conflict with local law. The State engineer shall forward, for information, a copy of his decision with supporting data to the Federal Emergency Administration of Public Works, Washington, D. C. In case of serious doubt, the State engineer should request the advice of the Federal Emergency Administration of Public Works prior to making of any decision.

In determining the lowest responsible bid, the following elements will be considered: Whether the bidder involved (a) maintains a permanent place of business; (b) has adequate plant equipment to do the work properly and expeditiously; (c) has a suitable financial status to meet obligations incident to the work; (d) has appropriate technical experience.

6. All bids submitted must state the minimum wage rates applicable to the project, as set forth in the Resolution of the Special Board for Public Works, page 9.

7. The applicant must call to the attention of all contractors for construction and/or the purchase of materials any clauses which may be incorporated in the Loan and Grant Agreement other than in part III thereof, or in the Grant Agreement other than in part II thereof, which refer in any way to the construction of the project. Such clauses in substance should be written into each contract which may reasonably be affected by such clauses.

B. BONDS AND INSURANCE

1. *Public Liability Insurance.*—Public liability insurance in an amount satisfactory to the State engineer is required to be taken out on every Public Works project, if permitted by the laws of the State in which the project is located.

2. *Performance Bonds.*—Performance bonds in the amount of 100 per cent of the full contract price are required by the Public Works Administration for every construction contract made between a contractor and the applicant. Such bonds shall include a clause giving materialmen a right of action on the bonds second only to the right of the applicant. Exceptions, if justified by the facts of the case, may be made to the requirement of 100 per cent coverage by the Washington office of the Public Works Administration, upon request and recommendation of the State Engineer.

3. *Labor and Materialmen's Bonds.*—In those States in which the local law requires a labor and materialmen's bond separate and distinct from the performance bond, such labor and materialmen's bond must be provided in the amount of at least 50 per cent of the contract price in addition to the performance bonds in the amount of 100 per cent of the contract price.

Note.—Requirement of the State Law as to form and content of the bonds and/or insurance in addition to the requirements herein specified shall be observed. The amount of coverage provided by State law is the minimum requirement of coverage in any case.

4. *Labor Bonds.*—In all other States, in addition to the performance bond in the amount of 100 per cent of the contract price, there is required a labor bond in an amount equal to the largest estimated aggregate pay roll for any one month during construction. A form of labor bond will be furnished by the Public Works Administration, which form shall be used in all cases where it is compatible with local law. Since it is deemed advisable that the Washington office approve any changes in the form of the bond which may be necessary, it is suggested that the State engineer have the necessary changes and amendments drawn up and submitted to the Washington office as quickly as possible.

C. CONSTRUCTION REGULATIONS

All work to be done on the project shall be subject to the following rules and regulations adopted by the Federal Emergency Administrator of Public Works (herein called the "Administrator") to carry out the purposes and control the administration of Title II of the Act, which rules and regulations shall be incorporated verbatim in all construction contracts for work on the project:

1. (a) Convict labor.—No convict labor shall be employed on the project, and no materials manufactured or produced by convict labor shall be used on the project.

(b) Thirty-hour week.—Except in executive, administrative, and supervisory positions, so far as practicable and feasible in the judgment of the Government engineer, no individual directly employed on the project shall be permitted to work more than 8 hours in any 1 day nor more than 30 hours in any one week: Provided, That this clause shall be construed to permit working time lost because of inclement weather or unavoidable delays in any 1 week to be made up in the succeeding 20 days.

(c) No work shall be permitted on Sundays or legal holidays except in cases of emergency.

2. Wages.—(a) All employes directly employed on this work shall be paid just and reasonable wages which shall be compensation sufficient to provide for the hours of labor as limited, a standard of living in decency and comfort. Such wages shall in no event be less than the minimum hourly wage rates for skilled and unskilled labor prescribed by the Administrator for the zone or zones in which the work is to be done, viz.:

Skilled labor..
Unskilled labor....................................

(b) In the event that the prevailing hourly rates prescribed under collective agreements or understandings between organized labor and employers in effect on April 30, 1933, shall be above the minimum rates specified above, such agreed wage rates shall apply: Provided, That such agreed wage rates shall be effective for the period of this contract, but not to exceed 12 months from the date of the contract.

(c) The above designated minimum rates are not to be used in discriminating against assistants, helpers, apprentices, and serving laborers who work and serve skilled journeymen mechanics and who are not to be termed as "unskilled laborers."

(d) The provisions of this contract relating to hours and minimum wage rates for labor directly employed on the project shall for the purposes of this contract, to the extent applicable, supersede the terms of any code adopted under Title I of the act permitting longer hours or lower minimum wage rates.

(e) All employes shall be paid in full not less often than once each week and in lawful money of the United States, unless otherwise permitted by the Government engineer, in the full amount accrued to each individual at the time of closing of the pay roll, which shall be at the latest date practicable prior to the date of payment, and there shall be no deductions or rebates on account of goods purchased, rent, or other obligations, but such obligations shall be subject to collection only by legal process: Provided, however, That this clause shall not be construed to prohibit the making of deductions for premiums for compensation and medical aid insurance, in such amounts as are authorized by the laws of..........................to be paid by employes, in those cases in which, after the making of the deductions, the wage rates will not be lower than the minimum wage rates herein established.

(f) A clearly legible statement of all wage rates to be paid the several classes of labor employed on the work, together with a statement of the deductions therefrom for premiums for workmen's compensation and/or medical aid insurance authorized by the laws of................................, should such deductions be made, shall be posted in a prominent and easily accessible place at the site of the work, and there shall be kept a true and accurate record of the hours worked by and the wages, exclusive of all authorized deductions, paid to each employe, and the engineer inspector shall be furnished with a sworn statement thereof on demand.

(g) The Board of Labor Review (herein called the "Board") shall hear all labor issues arising under the operation of this contract and such issues as may result from fundamental changes in economic conditions during the life of this contract.

(h) The minimum wage rates herein established shall be subject to change by the Administrator on recommendation of the Board. In the event that, as a result of fundamental changes in economic conditions, the Administrator, acting on such recommendation, from time to time establishes different minimum wage rates (referred to in paragraph 2 (a), (b), and (c) hereof) all contracts for work on the project shall be adjusted accordingly by the parties thereto so that the contract price to the contractor under any contract or to any subcontractor under any subscontract shall be increased by an amount equal to any such increased cost, or decreased in an amount equal to such decreased cost.

(i) Engineers, architects, and other professional and subprofessional employes engaged in duties normally done at the site of the project shall receive at least the prevailing rates for the various types of service to be rendered, provided that in no case shall professional employes receive less than the following weekly compensation for 40 hours or less irrespective of the number of hours employed: $36.00 in the northern zone; $33.00 in the central zone; and $30.00 in the southern zone. Where the working week is longer than 40 hours, weekly compensation shall be increased proportionally. Compensation under this paragraph shall be subject to the approval of the Government Engineer."

3. (a) Labor preferences.—Preference shall be given, where they are qualified, to ex-service men with dependents, and then in the following order: (1) To citizens of the United States and aliens who have declared their intention of becoming citizens, who are bona fide residents of (political subdivision and/or county)................................and (2) to citizens of the United States and aliens who have declared their intention of becoming citizens, who are bona fide residents of (State, Territory, or district)...............................; Provided, That these preferences shall apply only where such labor is available and qualified to perform the work to which the employment relates.

(b) Employment services.—To the fullest extent possible, labor required for the project and appropriate to be secured through employment services shall be chosen from the lists of qualified workers submitted by local employment agencies designated by the United States Employment Service: Provided, however, That union labor, skilled and unskilled, shall not be required to register at such local employment agencies but, if such labor is desired by the employer, shall be secured in the customary ways through recognized union locals. In the event, however, that employers who wish to employ union labor are not furnished with qualified union workers by the union locals which are authorized to furnish such labor residing in the locality within 48 hours (Sundays and holidays excluded) after request is filed by the employer, all labor shall be chosen from lists of qualified workers submitted by local agencies designated by the United States Employment Service. In the selection of workers from lists prepared by such employment agencies and union locals, the labor preferences provided in section (a) of this paragraph 3 shall be observed, and preference shall be given to those unemployed at the date of registration who, at the date of selection, have no other available employment.

(c) Complicance with Tile I of the Act.—The following sections 7 (a) (1) and 7 (a) (2) of Title I of the Act shall be observed:

(1) That employes shall have the right to organize and bargain collectively through representatives of their own choosing, and shall be free from the interference, restraint, or coercion of employers of labor, or their agents, in the designation of such representatives or in self-organization or in other concerted activities for the purpose of collective bargaining or other mutual aid or protection; (2) that no employe and no one seeking employment shall be required as a condition of employment to join any company union or to refrain from joining, organizing, or assisting a labor organization of his own choosing.

4. Human labor.—The maximum of human labor shall be used in lieu of machinery wherever practicable and consistent with sound economic and public advantage; and to the extent that the work may be accomplished at no greater expense by human labor than by the use of machinery, and labor of requisite qualifications is available, such human labor shall be employed.

5. Compensation insurance.—Every employer of labor shall provide, if permitted by the laws of.............................., adequate workmen's compensation insurance for all labor employed by him on the project who may come within the protection of such laws and shall provide, where practicable, employers' general liability insurance for the benefit of his employes not protected by such compensation laws, and proof of such insurance satisfactory to the Government engineer shall be given. Where it is not permitted by law that such insurance be provided, some method satisfactory to the Administrator must be provided by which the employes may, by paying the entire amount of the premiums, derive a similar protection.

6. Persons entitled to benefits of labor provisions.—There shall be extended to every person who performs the work of a laborer or of a mechanic on the project or on any part thereof the benefits of the labor and wage provisions of this contract, regardless of any contractual relationship between the employer and such laborer or mechanic. There shall be no discrimination in the selection of labor on the ground of race, creed, or color.

7. Withholding payment.—Under all construction contracts, ...may withhold from the contractor so
(The borrower)
much of accrued payments as may be necessary to pay to laborers or mechanics employed on the work the difference between the rate of wages required by this contract to be paid to laborers or mechanics on the work and the rate of wages actually paid to such laborers or mechanics.

8. Accident prevention.—Reasonable precautions shall at all times be exercised for the safety of employes on the work and applicable provisions of the Federal, State, and municipal safety laws and building and construction codes shall be observed. All machinery and equipment and other physical hazards shall be guarded in accordance with the safety provisions of the Manual of Accident Prevention in Construction of the Associated General Contractors of America, unless and to the extent that such provisions are incompatible with Federal, State, or municipal laws or regulations.

9. (a) NRA Compliance.—The contractor shall comply with each approved code of fair competition to which he is subject, and if he is engaged in any trade or industry for which there is no approved code of fair competition, then as to such trade or industry with an agreement with the President under Section 4 (a) of the National Industrial Recovery Act (President's Reemployment Agreement), and..
(The borrower)
shall have the right, subject to the approval of the Government engineer, to cancel this contract for failure to comply with this provision and make open market purchases or have the work called for by this contract otherwise performed at the expense of the contractor. So far as articles, materials or supplies produced in the United States are concerned, no articles, materials or supplies shall be accepted or purchased for the performance of the work nor shall any subcontracts be entered into for any articles, materials or supplies, in whole or in part produced or furnished by any person who shall not have certified that he is complying with and will continue to comply with each code of fair competition which relates to such articles, materials or supplies, and/or in case there is no approved code for the whole or any portion thereof then to that extent with an agreement with the President as aforesaid.

(b) Local preference.—So far as practicable, and subject to the provisions of section (a) of this paragraph 9, preference shall also be given to the use of locally produced materials if such does not involve higher cost, inferior quality, or insufficient quantities, subject to the determination of the Government engineer; but there shall be no requirement providing price differentials for, or restricting the use of materials to, those produced within the Nation or State.

10. (a) Inspection of records—The Administrator, through his authorized agents, shall have the right to inspect all work as it progresses, and shall have access to all pay rolls, records of personnel, invoices of materials, and any and all other data relevant to the performance of this contract. There shall be submitted to the Administrator, through his authorized agents, the names and addresses of all personnel and such schedules of the cost of labor, costs and quantities of materials, and other items, supported as to correctness by such evidence, as, and in such form as, the Administrator, through his authorized agents, may require. The submission and approval of said schedules, if required, shall be a condition precedent to the making of any payment under the contract.

(b) There shall be provided for the use of the engineer inspector such reasonable facilities as he may request. In case of dispute the Government engineer shall determine the reasonableness of the request.

11. Reports.—Every employer of labor on the project shall report within 5 days after the close of each calendar month, on forms to be furnished by the United States Department of Labor, the number of persons on their respective pay rolls directly connected with the project, the aggregate amounts of such pay rolls, and the man-hours work, wage scales paid to the various classes of labor, and the total expenditures for materials. Two copies of each of such monthly reports are to be furnished to the Government engineer, and one copy of each to the United States Department of Labor. The contractor under any construction contract shall also furnish .... (The borrower) to the Government engineer and to the United States Department of Labor the names and addresses of all subcontractors on the work at the earliest date practicable.

12. There shall be provided all necessary services and all materials, tools, implements, and appliances required to perform and complete entirely and in a workmanlike manner the work provided for in this contract. Except as otherwise approved in writing by the Government engineer, such services shall be paid for in full at least once a month and such materials, tools, implements, and appliances shall be paid for at least once a month to the extent of 90 per cent of the cost thereof to the contractor, and the remaining 10 per cent shall be paid 30 days after the completion of the part of the work in or on which such materials, tools, implements, or appliances are incorporated or used.

13. Signs.—Signs bearing the legend Public Works Project No. ...... shall be erected in appropriate places at the site of the project.

14. All reasonable rules and regulations which the Public Works Administration may prescribe toward the effectuation of the matters covered by paragraphs 1 to 13, inclusive, shall be observed in the performance of the work.

15. Subcontractors.—(a) Appropriate provisions shall be inserted in all subcontracts relating to this work to insure the fulfillment of all provisions of this contract affecting such subcontractors, particularly paragraphs 1 to 14, inclusive.

(b) No bid shall be received from any subcontractor who has not signed U. S. Government Form No. PWA 61, revised (March 1934).

16. Termination for breach.—In the event that any of the provisions of paragraphs 1 to 15, inclusive, of this contract are violated by the contractor under the construction contract or by any subcontractor under any subcontract on the work, ... may, subject to the approval of the (The borrower) Government engineer, and upon request of the Administrator, shall terminate the contract by serving written notice upon the contractor of its intention to terminate such contract, and, unless within 10 days after the serving of such notice such violation shall cease, the contract shall, upon the expiration of said 10 days, cease and terminate. In the event of any such termination .... may take over the work and prose- (The borrower) cute the same to completion or otherwise for the account and at the expense of the contractor and/or such subcontractor, and the contractor and his sureties shall be liable to .... (The borrower) for any excess cost occasioned .... in the event (The borrower) of any such termination, and .... may take (The borrower) possession of and utilize in completing the work, such materials, appliances, and plant as may be on the site of the work, and necessary therefor. This clause shall not be construed to prevent the termination for other causes provided in the construction contract.

17. Definitions.—The term "Act" as used herein refers to the National Industrial Recovery Act. The term "Government engineer" as used herein shall mean the State engineer (PWA) or his duly authorized representative, or any person designated to perform his duties or functions under this agreement by the Administrator. The term "engineer inspector" as used herein refers to State engineer inspectors, resident and assistant resident engineer inspectors, and supervising engineers, appointed by the Administrator. The term "materials" as used herein includes, in addition to materials incorporated in the project used or to be used in the operation thereof, equipment and other materials used and/or consumed in the performance of the work.

It shall be the duty of the State engineer (PWA) to see that these provisions are inserted in all construction contracts and subcontracts for work on non-Federal projects, both public and private (but not in contracts for the purchase of materials), which are financed in whole or in part by the Federal Emergency Administration of Public Works, subject only to the following:

(1) Paragraphs 1 to 17, inclusive, must be inserted verbatim, except that—

(a) The name of the applicable local area shall be inserted in paragraph 3 (a), and the name of the applicable State in paragraph 2 (e) and (f), and in paragraph 5.

(b) The modifications discussed in section (3), below, may be made if the facts warrant.

(2) The State engineer (PWA) will cause to be inserted in paragraph 2 the applicable wage scale for the zone in which the project is located. (See Resolution of the Special Board for Public Works, p. 9.) Where a project is located in more than one zone, the higher rate will prevail.

(3) The 30-hour week requirement shall be construed—

(a) To permit the limitation of not more than 130 hours' work in any 1 calendar month to be substituted for the requirement of not more than 30 hours' work in any 1 week on projects in localities where a sufficient amount of labor is not available in the immediate vicinity of the work.

(b) To permit work up to 8 hours a day or up to 40 hours a week on projects located at points so remote and inaccessible that camps or floating plant are necessary for the housing and boarding of all the labor employed.

In case the Government engineer shall determine prior to advertisement that any project falls within the terms of (a) hereof, the following proviso shall be added at the end of paragraph 1 (b):

And provided further, The Government engineer having determined prior to advertisement that a sufficient amount of labor is not available in the immediate vicinity of the work, that a limitation of not more than 130 hours' work in any 1 calendar month may be substituted for the requirement of not more than 30 hours' work in any 1 week on the project.

In case the Government engineer shall determine prior to advertisement that any project falls within the terms of (b) hereof, the following section shall be substituted in the place of paragraph 1 (b):

(b) Hours of labor.—Except in executive, administrative, and supervisory positions, so far as practicable and feasible in the judgment of the Government engineer, no individual directly employed on the project shall be permitted to work more than 40 hours in any 1 week nor more than 8 hours in any 1 day. The Government engineer having determined prior to advertisement that the work will be located at points so remote and inaccessible that camps or floating plant are necessary for the housing and boarding of all the labor employed, this provision shall apply in lieu of the usual 30-hour terms.

D. WAGE RATES

The Special Board for Public Works has adopted the following resolution regarding wage rates:

1. Be it resolved, That for the purpose of determining wage rates on all construction financed from funds appropriated by the Administrator of Public Works under the authority of the National Industrial Recovery Act, the United States shall be divided into three zones as follows:

Southern Zone: South Carolina, Georgia, Florida, Arkansas, Alabama, Mississippi, Louisiana, Arizona, Oklahoma, Texas, and New Mexico.

Central Zone: Delaware, Maryland, Virginia, Tennessee, Colorado, Utah, California, North Carolina, West Virginia, Kentucky, Missouri, Kansas, Nevada, and District of Columbia.

Northern Zone: Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Indiana, Wisconsin, Minnesota, Nebraska, Wyoming, Oregon, South Dakota, Idaho, Pennsylvania, Ohio, Michigan, Illinois, Iowa, North Dakota, Montana, and Washington.

The hourly wage rates to be paid on construction projects in these zones shall not be less than the following:

Southern Zone:	
Skilled labor	$1.00
Unskilled labor	.40
Central Zone:	
Skilled labor	1.10
Unskilled labor	.45
Northern Zone:	
Skilled labor	1.20
Unskilled labor	.50

2. Be it further resolved, That in the event that the prevailing hourly rate prescribed under collective agreements or understandings between organized labor and employers on April 30, 1933, shall be above the minimum set for any district within that zone, that agreed wage rate shall be the rate to be paid for employes on construction projects financed from funds appropriated by the Administrator of Public Works under the authority of the National Industrial Recovery Act.

3. Be it further resolved, That the rates specified in paragraphs 1 and 2 shall be effective during the life of any contract financed from funds appropriated by the Administrator of Public Works under the authority of the National Industrial Recovery Act, but for a period not to exceed 12 months.

4. Be it further resolved, That the above designated minimum rates are not to be used in discriminating against assistants, helpers, apprentices and serving laborers who work with and serve skilled journeymen mechanics and who are not to be termed as "unskilled laborers."

5. Be it further resolved, That there shall be created a Board of Labor Review which shall hear all issues arising under the operation of all contracts financed from funds appropriated by the Administrator of Public Works under the authority of the National Industrial Recovery Act and from such problems as may result from fundamental changes in economic conditions during the life of these contracts. The Board of Labor Review to be created shall consist of 3 members, 1 to represent labor, 1 to represent contractors, and a chairman who shall represent the Federal Emergency Administration of Public Works. The members of this board shall be appointed by the President of the United States but no members shall be connected in any way with any organization of building workers or directly connected with, or have any interest in, contracting. The chairman shall not be in any way connected with the Federal Emergency Administration of Public Works. Decisions of the Board of Labor Review shall be binding upon all parties.

Note.—The rates stated in this resolution do not apply to projects carried out under authority of section 204 of the National Industrial Recovery Act.

In the event that any question shall be raised (prior to the awarding of the contract) as to what wage rates prevail in any district under agreements and understandings between organized labor and employers, the United States Department of Labor shall determine such rates.

E. HOURS OF LABOR

See the self-explanatory provision of C, paragraph 1 (b) and (c), page 3. See also C, section (3), pages 8-9.

These provisions apply to all construction contracts and subcontracts for work on any non-Federal project, both public and private (but not to contracts for the purchase of materials), which are financed in whole or in part by the Federal Emergency Administration of Public Works.

F. EMPLOYMENT OF LABOR

1. Employers may use organized or unorganized labor. Unorganized labor shall be obtained from local employment agencies designated by the United States Employment Service, while organized labor must be sought in the first instance from union locals. The use of labor is, however, subject to the provisions of sections 7 (a) (1) and 7 (a) (2) of title I of the National Industrial Recovery Act.

See the detailed provisions of paragraph 3 (b) and (c), page 5 of this Bulletin.

2. Engineers will keep in touch with the State reemployment director of the United States Employment Service who cooperates with the State relief director. The purpose of this contact is to keep informed of the status of the labor market in the State and to furnish information to public bodies and other applicants and to contractors relative to the availability of labor of various classes.

3. Immediately upon the advertisement of any project, the public body or private applicant will be required to furnish the State reemployment director with a copy of such advertisement, together with information regarding the location of the project, the date of commencement and probable completion of the project, and an estimate of the number of each of the different classes of skilled and unskilled labor that will be required in the execution of the work. As soon as possible after receipt of such information, the State reemployment director will supply the applicant with the exact designation and address of the agency selected to prepare the employment lists for each project so that the name of the agency may be available to the applicant prior to the award of the contract. The applicant should be instructed by the State engineer to keep the State reemployment director advised as to the approximate time at which work will be started, so that the locally designated employment agency may have adequate opportunity to prepare employment lists and make them available to contractors on short notice. When the name of the employment agency for any project is known prior to advertisement, the applicant should be instructed to insert such name in the advertisement. Prospective bidders are entitled to this information at the earliest possible time.

II. APPLICATIONS

1. As the action by the State engineer (PWA) on all applications is subject to review and final action by the Administrator, all information to the press or for other publication or public information on action taken on projects will be handled in the central office in Washington. No such information will be released by State organizations. It is important that this principle be strictly observed to avoid possible premature, conflicting, or adverse publicity.

2. Particular attention is invited to the routing of applications covering Federal projects, river and harbor improvements, and river or drainage improvements required to satisfy any obligation incurred by the United States through a treaty with a foreign Government, railroad maintenance and equipment, and housing and slum clearance. Applications of this character will not be examined by the State engineer but will be forwarded direct to the Deputy Administrator, Washington, D. C.

3. Instructions as to the form and scope of report required on each application are contained in Bulletin No. 1, dated August 10, 1933. Careful attention to these instructions will expedite action on applications in the central office.

4. The preparation of detailed plans and specifications is a function of the applicant subject to changes and final approval by the State engineer (PWA).

5. No printed form will be furnished or required for submitting an application for a loan. The data and information called for by Circulars Nos. 2, 3, and 4 should be submitted in the order, by paragraph and subparagraph, as prescribed in those circulars.

6. Detailed drawings are not required with an application. General drawings, showing the location, character, and extent of the construction proposed but in sufficient detail to permit checking of estimates and of otherwise determining the soundness of the project, will be sufficient.

7. State engineers (PWA) should expedite in every practicable ways the examination of applications and other submittal to the Administrator for his action.

8. All applications received will be examined and submitted to the Administrator for his action, whether recommended for approval or disapproval.

9. Each State engineer (PWA) will submit a report of applications (in duplicate) at the close of business each Saturday to the Deputy Administrator of Public Works showing the following:

(1) Total number of applications received to date.

(2) Number of applications examined and forwarded to date.

(3) Number of applications received during the past week to show—

(a) Applicant's name and address.

(b) Character of project (toll-bridge, water works, etc.)

(c) Loan requested.

(d) Grant requested.

III. LOANS AND GRANTS

1. The amount of the grant, if allowed, is limited to 30 per cent of the cost of the labor and materials employed upon the project. The actual amount of the grant in any instance, therefore, cannot be definitely determined until the work is completed and the itemized costs accurately known.

Where the work is done by contract, the base of the grant is the aggregate of the payments made by the public body pursuant to the contract for the construction, repair, or improvement of the project, plus its cost of inspection and supervision in the field. Where the work is done by force account, the base of the grant is the direct cost of material in place, plus inspection and supervision in the field.

2. All inquiries in regard to public highways to be constructed under the provisions of section 204 (a), National Industrial Recovery Act, should be referred to the respective State highway departments. Applications for loans (and grant) to municipalities for the construction of additional roads, not included in the State highway program, should be filed with the State engineer in the same manner as other applications.

3. Where State funds for road projects are available, applications for financing them under the loan-and-grant basis may be received. It is not possible, however, to make a 30 per cent grant on a blanket proposed expenditure by a State. Each section of road to be so constructed by the State under the loan-grant basis must be a complete project by itself and submitted with such necessary plans and data as will permit proper estimate of cost. The Administrator will allow the 30 per cent grant on such projects as are approved after the State has borne its proportion of the cost. All such projects reaching the central office will be sent to and checked by the Bureau of Public Roads, which will also look after their inspection during construction. This will insure that all such construction work is being carried on in accordance with policies of the Federal Bureau of Public Roads.

HAROLD L. ICKES, *Administrator.*

Research Fellowship to Study Steel Floor Construction

The American Institute of Steel Construction has decided to endow a Research Fellowship at Lehigh University, Bethlehem, Pa., which goes into effect immediately and be extended over a period of two years. The work will relate to research on steel floor construction and will involve the design of battledeck floors, made of flat steel plates welded to steel beams, to carry concentrated live loads.

During the past several years the American Institute of Steel Construction had the National Bureau of Standards carry on a comprehensive research on battledeck floors, which developed valuable data regarding fireproofing and behavior under distributed loads. The Fellowship at Lehigh University will continue this work and develop it in the particular field of bridge floors.

The investigation on the flat steel plate floor will be carried out under Professor Inge Lyse of the Department of Civil Engineering at Lehigh in consultation with the Technical Research Committee of the American Institute of Steel Construction. The personnel of this committee includes Aubrey Weymouth of Post & McCord, Inc.; Jonathan Jones of McClintic-Marshall Corp.; J. R. Lambert of Phoenix Bridge Co.; Dr. O. E. Hovey of the American Bridge Co.; H. G. Balcom, Consulting Engineer of New York, and F. H. Frankland of the American Institute of Steel Construction.

BITUMINOUS SURFACE Construction With a New Type Roller

A TEST section of bituminous topping road construction on an 8 in. gravel base was completed in Zilker Park, at Austin, Texas, on June 7, 1934. The road had a 20 ft. surface and 1½ in. bituminous top. In this test, an Austin Roll-A-Plane was used for the leveling and compacting of materials.

Given the task of building a high class base for this kind of construction, one, from choice, would hardly select pit run gravel ranging in size from dust to 6 or 8 in. in diameter. But such was the 8 in. layer of material already in place on the Reptile Institute Drive in Zilker Park, where the test was made.

Ony a few weeks before resurfacing began, the road had been graded and graveled by CCC workers with hand labor exclusively. Part of the work was through cuts where the gravel rested on a solid rock subgrade; other parts ran along practically at the original ground level or over rock fills.

To utilize the gravel as a base, it was first loosened with a light scarifier and leveled with a blade grader. It was then rolled dry with the Roll-A-Plane and further leveled by blading. By successive watering, blading and rolling, a firmly bonded, uniform, smooth surface was produced.

With the Roll-A-Plane, an important yet heretofore undeveloped principle of road construction is utilized, namely, the force of compaction applied as a kneading action to the aggregates under compression. This action is accomplished by the use of a center wheel of smaller diameter.

Being readily movable by hydraulic control to any required vertical position, the center roller was first operated about ½ in. above the plane of the front and rear wheels. As leveling and compaction progressed, this roller was gradually lowered to the true plane of the other rolls. When in this position, it acts as an automatic indicator of surface smoothness: Over a low area it will cease to rotate; over an area too high or too hard to admit of ready adjustment to the plane level, the front roller will be raised off the surface. This feature thus permits the attending workmen to supply new or to remove excess material at the time of the initial rolling to assure a perfect surface.

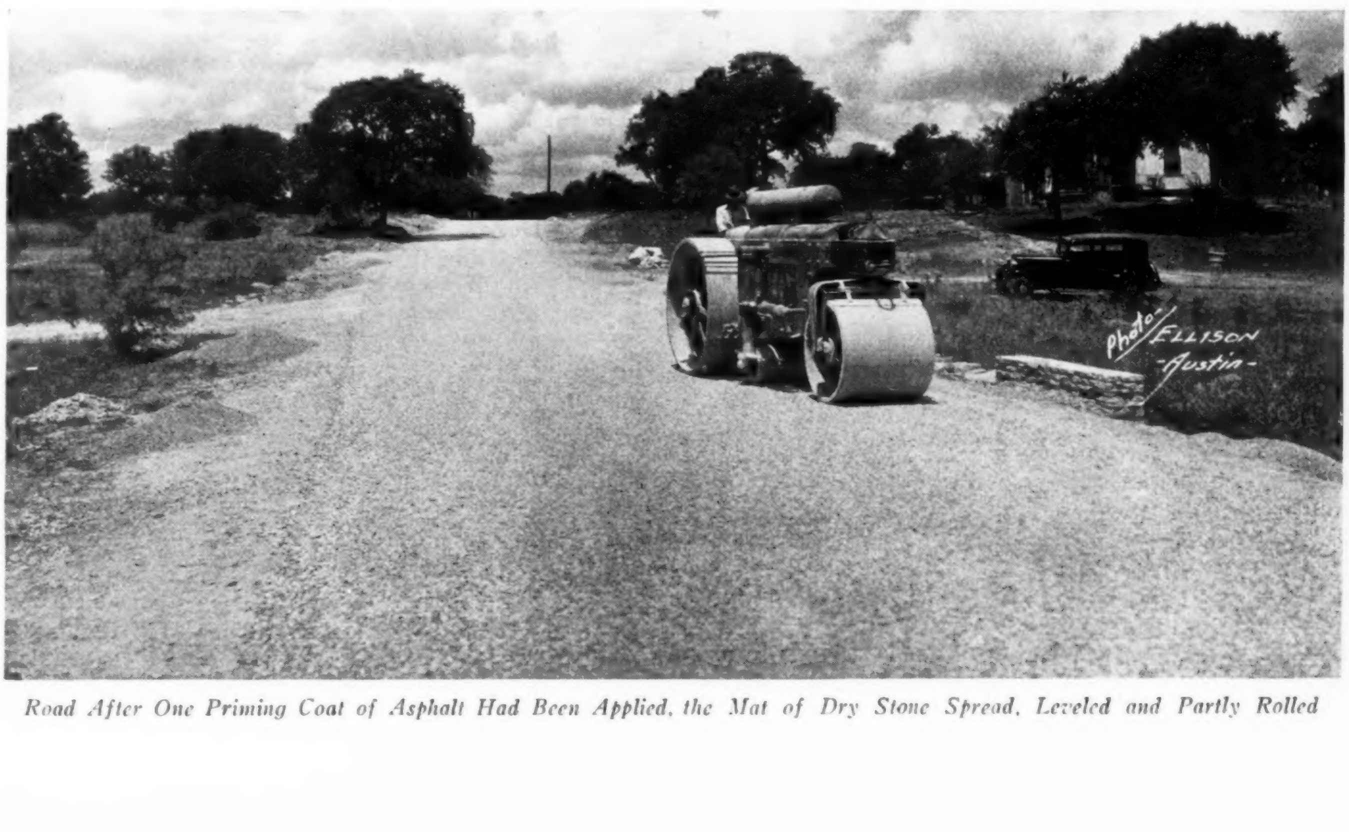
Under the conditions encountered on Reptile Institute Drive, some of the oversized aggregates had to be shattered with a heavy maul, or entirely removed, to relieve high spots; while a sprinkling of fresh gravel brought the low spots to the true level.

On other sections of the park road work, where a finer, better graded aggregate was in place, no hand shaping was required.

So much of the actual work of compaction was accomplished with the center roller that it was found unnecessary to lap the rear wheels.

Difficult as this oversized material was to manipulate with machinery, it developed that, with the Roll-A-Plane, not only was less rolling required to finish the gravel base but also that the actual blading time was less than that required on adjacent sections of the park roads built with an ordinary three wheeled roller.

Before the bituminous topping was applied, the entire base was tested for smoothness with an Austin surface



Road After One Priming Coat of Asphalt Had Been Applied, the Mat of Dry Stone Spread, Leveled and Partly Rolled

inspector. It was found to meet the specifications usually required for the highest type of pavement surfaces.

After the base was prepared and before the topping was applied, the dust was removed from the surface by means of a rotary sweeper.

The method and stages of constructing the 1½ in. bituminous topping were as follows:

1. The gravel base as prepared was primed with a 0.25 gal. treatment of 250 penetration asphalt applied at a temperature of 350 degrees to 450 degrees.
2. Number One crushed stone (¾ in. to 1¼ in.) was spread at the rate of one cu. yd. to 40 sq. yd. of surface.
3. The stone was evently distributed with a broom drag drawn behind a light truck.
4. After brooming, the stone was rolled dry with the Roll-A-Plane, which keyed up the stone and ironed it out to a true surface.
5. The second application of asphalt was then applied. This was done at the rate of 0.45 gal. per square yard. The asphalt for both treatments being the same.
6. The second application of asphalt was covered with Number Two pea-gravel at the rate of one cu. yd. to 80 sq. yd. of surface.
7. The cover coat of pea-gravel was broomed the same as the first course stone.
8. After brooming, the final rolling was done with the Roll-A-Plane, after which the roadway was opened to traffic.

For the spreading of the gravel about 125 CCC workers, who had their encampment in the westerly part of the park, were employed.

The advantages of starting with the gravel base and building the succeeding layers of bituminous topping each of even thickness, each of uniform compaction and each with an invariably true surface contour became apparent as the work in Zilker Park progressed. While about three miles of the same type roads were built in the park, this test section was the only one on which the Roll-A-Plane was used exclusively and on which a base rolled to a true plane was attempted.

The even base of the test section made it possible to apply the succeeding layers of stone in truly parallel courses, so that as the rolling was done the center roller could be operated in its true plane position and produce the desired surface effect.

The road work in Zilker Park was done by the city of Austin, Texas. The officials directly interested in the work were:

Tom Miller, Mayor; Guyton Morgan, City Manager; J. E. Motheral, City Engineer; Joe Bowles, Superintendent of Streets; and James A. Duggan, in charge of resurfacing.

The CCC workers were in charge of N. H. Lee, Camp Superintedent, and Captain Fred B. Widmoyer.

The asphalt was applied by Henry Hedges, contractor, Houston, Texas.

▼

Gilmore Now With Asphalt Institute

F. S. Gilmore, formerly Maintenance Engineer of the Kansas State Highway Department, is now the representative of the Asphalt Institute for the states of Kansas, Missouri, Iowa, and Arkansas. His office is in the Diercks Bldg., Kansas City, Mo. His general duties are to cooperate with the highway departments and act as liaison between the highway department and the asphalt industry. Due to the nature of the type of construction available from the funds and the mileage to be covered, most of Mr. Gilmore's work will be with low cost roads for the time being.

Year's Work on Federal Highways Nearly Equals Road Around Earth

Record speed in putting highway work under way is reported by the Bureau of Public Roads, U. S. Department of Agriculture. On June 23, 1934, just one year after apportionment of the $400,000,000 highway appropriation provided by the National Industrial Recovery Act, an average of nearly $1,000,000 a calendar day had been put to work by the State highway departments in the construction of public works highways. The improvement of more than 22,000 miles of public roads and streets—a mileage sufficient to build a road almost around the world—will be the result of the expenditure.

The record of the road building operation under the supervision of the Bureau of Public Roads showed on June 23, 1934, the following disposition of the $394,000,000 apportioned:

Status	Number of Projects	Public Works Funds	Miles of Highways
Projects completed	2.161	$ 66,040,000	6,360
Projects under construction	4,963	266,190,000	14,062
Projects awarded but not under construction......	580	18,258,000	1,006
Total contracts awarded	7,704	$350,488,000	21,428
Projects approved but not under contract.........	394	15,440,000	871
Total obligated	8,098	$365,928,000	22,299
Amount apportioned......		$394,000,000	
Percentage of apportioned funds obligated to projects		92.9	

The task was complicated by the fact that new relationships between Federal and state highway authorities had to be established in municipal secondary road construction. The preparation of programs by the various state highway departments also was necessary before construction could begin. In spite of the new relationships necessary, the state highway departments functioned smoothly and effectively in the $400,000,000 highway program, as had been anticipated by Federal authorities.

Of the part of the $394,000,000 fund available for roads on the Federal-aid highway system outside of cities, 95.4 per cent of the available money has been allotted to projects for improvement of 11,922 miles of highways, of which 4,061 miles have been completed in the year. On extensions of the Federal-aid highway system into municipalities, 89.3 per cent of the funds has been obligated on 1,813 miles of wide city streets with much complicated construction, of which 433 miles have been completed. In the secondary road program involving improvement of rural roads not on the Federal-aid highway system 92.3 per cent of the funds available has been obligated for improvement of 8,564 miles of highways of which 1,866 miles have been completed in the year.

Employment under the program totaled 246,192 men on June 23, 1934. This is only the direct employment on the roads and does not include the workers indirectly employed in quarries, mills, and factories and in the transportation of road materials, the number of which is estimated at nearly twice the direct employment.

The elimination of many traffic hazards is one of the chief results accomplished in the year's work. Hazards such as narrow roads and bridges and dangerous grade crossings at both railroads and highways have been reduced in number. Sidewalks have been provided to protect pedestrians on heavily-traveled highways. Every state is now making provision for roadside improvement to increase the attractiveness of the roads.

COUNTY AND TOWNSHIP ROADS

A Section Devoted to Those Interested In Secondary Road Improvement

The Use of SHALE As a SURFACING MATERIAL

By D. B. Fugate
Inspector, Virginia Dept. of Highways

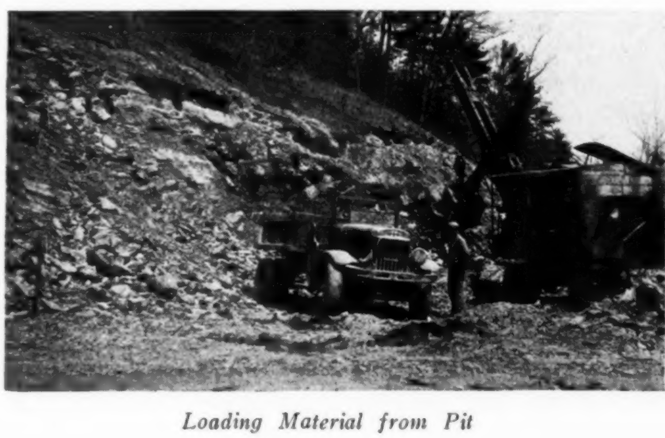
LOW cost roads, utilizing local materials for their surface course, are rapidly becoming a necessity because of diminishing revenues for road construction. The study of any local material which may be used as a surface course for this type of road therefore assumes a great importance to the highway engineer. Fortunately nature has endowed almost every locality with some material which may be successfully used in the construction of a low cost road, and there remains only the problem of how to utilize this material to the best advantage.

In the mountainous sections of Virginia and West Virginia, a great many first class roads are being built with shale as the surfacing material. When properly constructed and given an adequate surface treatment, these roads compare very favorably with the more expensive macadam roads constructed in the same vicinity. The accompanying photographs were taken during the construction of such a road on Virginia State Route 259 in Rockingham County. The construction methods herein described were followed with good results.

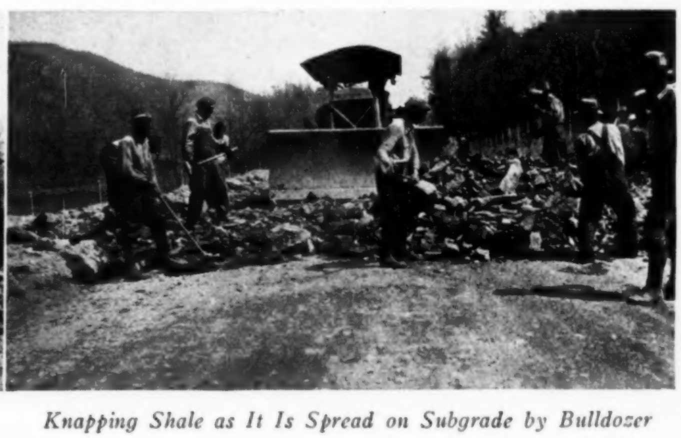
Shale is an argillaceous rock found in stratified form. Chemically the principal constituents of shale are silica and clay with lesser amounts of ferrous, magnesium, and calcium oxides. To be suitable as a road material, shale should have a very low clay content—not exceeding 20 per cent. A higher clay content will cause the surface to be unstable in wet weather. The amount of clay present can be judged by color and hardness. Shales with a minimum of clay are, as a reule, either blue or green in color and the use of explosives is necessary before they can be excavated with a power shovel. Yellow shales are almost entirely clay and should be avoided.

The selected material is placed upon a smooth, firm subgrade which has been bladed to the cross section desired in the finished surface. Adequate drainage must have been provided as the stability of a shale road depends largely upon this feature. Best results are obtained when the side ditches are below the subgrade; this insures the surface water running off quickly and prevents the ground water level reaching the surfacing material.

As the shale is dumped on the subgrade it is spread either by hand, road machine, or bulldozer, to a loose depth at least one-third in excess of the required compacted depth, a compacted depth of from 6 to 8 in. being required for average traffic. Before and during the spreading, the shale is hand knapped until all large



Loading Material from Pit



Knapping Shale as It Is Spread on Subgrade by Bulldozer

Blading a Shale Surface That Has Been Under Traffic for 4 Weeks

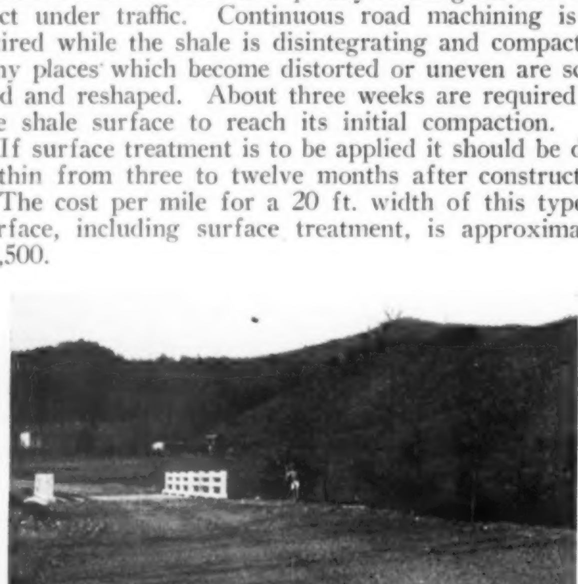
A shale Surface Immediately After Spreading and Knapping

pieces have been broken up and the material is uniform throughout. This operation is second in importance only to that of providing adequate drainage and should receive the most careful attention. Pot holes invariably develop in shale surfaces that have not been properly knapped, there being fine material left in one place and course material in another. Such places behave differently under weather and traffic conditions and uneven wear and settlement result.

After spreading, the surface is road machined to the desired cross section and opened to traffic. At this stage of construction the surface will be rough and resemble unrolled macadam but will quickly disintegrate and compact under traffic. Continuous road machining is required while the shale is disintegrating and compacting. Any places which become distorted or uneven are scarified and reshaped. About three weeks are required for the shale surface to reach its initial compaction.

If surface treatment is to be applied it should be done within from three to twelve months after construction.

The cost per mile for a 20 ft. width of this type of surface, including surface treatment, is approximately $3,500.



Completed Surface Course Ready for Surface Treatment

Grading Township Roads in Ontario

By L. E. Peterson

Road Superintendent, Blenheim Township, Drumbo, Ont.

I FEEL that the average township road superintendent with the limited amount of funds he has under his control must apply first degree economy, and so from this fact has to discard for the most part cross-section grading, and relieving hill elevations from his mind. Also, I think team grading too expensive a method to be carried out to any great extent, so I think the grading machine with tractor power is the most economical method for grading the township road.

One of the next essentials and a very important one indeed, is the operator of your grader, some men are artists with the grading machine, while others are only rooters, so retain your good operator even at greater cost, for he will be much the cheaper in the end.

Factors in Staking Out the Grade.—In staking out the grade the superintendent should be guided by three factors. (1) He should consider the kind of subsoil which will determine to a great extent the height of the grade, the depth and width of ditch required to get a natural drainage. (2) He should consider the amount of traffic the road has to accommodate which largely determines the width of grade that should be constructed. (3) He has to consider the amount of money he has, or can spend on that particular piece of work, so personally I have never felt that there can, or should be, a standard grade for all township roads.

In staking a grade, the alignment should be as near the center of the road allowance as possible, side stakes set back in line so as to have an alignment 34 ft. wide, so by leaving 3 ft. for each ditch and completing with 28 ft. driving surface. When width of grade has been decided and stakes are set, then I think a good teamster with a plow is a good way to get a straight line for your tractor to start to operate, throwing a furrow on each side in toward the shoulder of your grade in a straight line with the outside stakes. After the grade has been completed as far as possible with the grader, then all slack places on the shoulders should be completed by the teams with slush scrapers if the material is convenient, if not, with teams and wagons or trucks. All ditches should be back sloped, if not, the square shoulders on the outside of the ditch with the frost coming out in the spring will break off and fall into the ditch, hence your natural drainage is ruined to a great extent.

The height of the center of the grade should depend to some extent on the class of material used. I have never refrained from putting sods and other light soils in the center of the grade, but an allowance should be made of from 4 in. to 6 in. for settling. Where sods and soft materials are used in the grade, somewhat heavier class of metal should be used for the first coat on your grade. This will secure a fairly good foundation, with a resurface of a finer crushed material, which will give a smooth-driving surface.

As to the height of the center line of your grade, I do not think 6 in. is too much for your watershed on the 28-ft. or 30-ft. grade on the township road, where you are depending on natural drainage. All culverts should be widened to correspond with your grade and new ones constructed where necessary.

This is the widest and best type of grade which I would recommend for a township road carrying a considerable traffic.

Grading Back Roads.—On what we call a back road, or one that is not carrying much traffic, this road can be improved at a low cost by setting your side stakes to have a width of grade not less than 22 ft. or 24 ft. wide. By staking this width of grade, your work can practically all be completed with your tractor and grader. On some of these narrow roads a good deal of surface metal has been placed in the center of the road, by statute labor, and can be saved to some extent by using the grader fairly early in the season, before it has become too hard and dry, moving the gravel in a windrow to one side, then going to the opposite side, shoulder your road and complete the ditch on that side with your grader, then remove the gravel to the side on which the shoulder has been completed, then shoulder and complete ditch on opposite side, then take the gravel and spread uniformly to the width required over the grade to a width of 10 ft. or 12 ft. in the center of the grade. If funds will allow, give a resurface coat of 3 in. to 4 in. in depth of good wearing metal and you will have a very much improved township road at a very low cost.

Another class of grade that township men come in contact with very often, is the high, narrow grade with a very high crown of very good wearing material and which was considered a splendid type of grade for slow and horse-drawn vehicle traffic on account of its quick shedding of surface water, but which is very dangerous for motor traffic especially if the least bit icy.

This type of grade can also be improved and widened with the power grader at a very low cost by setting the ditches back from 2 ft. to 4 ft., bringing the material up to and widening the shoulders, then, scarify the center of the grade and spreading to a width which will give the side grade required, and if possible give a resurface coat of fine crushed gravel from 3 to 5 in. in depth and the width required.

Good Drainage Essential.—We must not lose sight of the fact that the good drainage of the grade is absolutely essential, and where side ditches do not give fairly good natural drainage, then the tile drainage should be resorted to, especially where the subsoil is of a springy nature. In this event I would advise the construction of a tile drain on each side of the grade not less than 3 ft. deep providing you can get a fall of not less than 3 in. in 100 ft. to the outlet.

There is no doubt in my mind that the lack of drainage is the cause of practically all the bog holes in our roads in the spring when the frost is going out.

I think you will agree with me when I say that frost will go much deeper into the grade that is soaked with water, than the grade that has proper drainage.

However, it is possible for the grade to be equipped with tile drainage on both sides, and not remedy the wet spot in the center of grade, from the fact that a hardpan wall may hinder the tile from drawing the moisture from the center of the grade. In a situation such as this I would recommend the construction of a cross drain as near the center of the portion of road which is giving the trouble, 2 ft. wide and at least as deep as the side drains, filling the ditch with stone and connecting with the tile drains on each side of grade which I think will in most cases have the desired effect in remedying the springy spot or bog which has been the cause of considerable inconvenience.

In introducing this subject of grading I have been trying to outline simple methods which might be helpful to the township road superintendent, because we township men cannot hope to carry out to any extent any elaborate class of cross-section grading, with the very limited amount of money we have at our disposal.

Acknowledgment.—The foregoing is an abstract of a paper presented at the Annual Conference on Road Construction, Toronto.

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Cost Accounting System for County Equipment

A necessary adjunct to any comprehensive system of municipal accounting is an up-to-date system of cost accounting for all major construction and maintenance equipment. No class of municipal property is more susceptible to abuse and misuse or more open to criticism for excessive operating costs.

An excellent system of cost accounting for the equipment of Harris County, Texas, has been installed by the county auditor under the law which gives him the right to prescribe forms and methods of accounting for all persons having the management of any county property. In a recent issue of County Progress, H. L. Washburn, Auditor of Harris County, outlines the system.

Advantages of System Summarized.—A few of the many advantages of this system may be summed up as follows: (1) the location of every piece of motor-driven and horse-drawn equipment in the county is known accurately at all times by the auditor's department: (2) when a piece of equipment becomes unserviceable on account of big operating cost, or low performance record, that fact is made known immediately through the detailed cost record kept on it, so that there is available a guide to indicate when equipment should be traded in or otherwise disposed of: (3) at the time of purchase of new equipment, there is available bases of comparisons of the cost and operating record of former equipment of the same character owned and operated by the county; (4) abuses or improper use of the equipment is reflected in the cost records compiled on it, so that it can be called to the attention of the person responsible for its care; (5) operating costs and results obtained from the equipment in one precinct, or department, may be compared with costs and results obtained from similar equipment in other precincts and departments.

Individual Cost Records.—Individual equipment numbers are assigned to each piece of new equipment purchased and thereafter all expense incurred on account of the particular equipment is charged to that number. Operating reports made in connection with the equipment carry the identifying equipment number. This system not only enables cost records to be kept on individual pieces of equipment and machinery, but it also enables this cost to be charged to the roads on which

the equipment worked, through the use of daily equipment reports from the field.

The information on the individual cost record maintained for each piece of equipment includes the following: quantity and cost of gasoline, grease, and oil consumed; quantity and cost of tires and tubes used; repairs and parts; accessories; garage, storage, washing; insurance, depreciation; et cetera. Statistical information and cost and operation units reflected on this sheet include the following: hours operated; miles traveled; tons handled; miles to the gallon of gasoline; hour rate; miles cost; and ton cost. Depreciation during the lifetime of the equipment is figured on an estimated basis, but when the equipment is disposed of, the entire record for it is recapitulated at the bottom of the cost record, and unit costs extended based on the known depreciation.

How Cost and Performance Data Are Assembled.—Punched cards on tabulating machines are used to assemble cost and performance data, and to prorate equipment charges to roads. The advantage of enabling rapid sorts and classifications. The substance of handling on tabulating cards is this: motor equipment cards are cut for each item of expense paid during the period chargeable to a specific equipment number. Classification matter is reduced to code numbers to enable handling through the machines. Information cut on the cards includes the equipment number, the equipment class, the date of purchase, paving audit number, name of department, fund, expense classification, amount of payment, quantity purchased, the type and division of the road worked on, the class of work done by the equipment, the hours operated, miles traveled, et cetera. Runs made from the tabulating cards are used as a basis for the postings to the eqquipment cost ledger.

Approximately 225 pieces of motor-driven and horse-drawn equipment are carried on the records of Harris County. Four precincts and 16 departments are charged with the ownership and responsibility of this equipment, which is located at widely separated points over the county.

The forms principally used in assembling cost and performance data on equipment are: Numerical book from which numbers are assigned; individual equipment cost ledger; daily work and equipment report from precinct employes; notice of change in status of equipment affecting inventories; monthly report from precincts of gas, oil and grease received; condition report used by departments, institutions, and precincts when old equipment is requested to be traded in on new equipment; and equipment mileage and operating report from departments and institutions.

The equipment cost system is separate and distinct from the inventory accounting system which includes the accounting for motor-driven and horse-drawn equipment in the same manner that other county moveable property is accounted for.

The present equipment cost system has been in effect in Harris County for six years, and full lifetime figures are now available on a number of pieces of equipment. The value of these records increases as information is added each year.

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MERSEY RIVER TUNNEL TO BE OPENED IN JULY.—It is understood that definite plans have been made for opening to traffic the new Mersey River Tunnel, about July 18, 1934. The total length of the tunnel is 2.62 miles. It connects Liverpool and Birkenhead, and has a capacity of 4,500 cars per hour, spaced 100 ft. apart, moving at 20 miles an hour. It is estimated to have cost about $36,111,000.

Piling Requirements for Bridges

A progress report on a cooperative investigation of the engineering experiment station of Ohio State University and the Ohio State Highway Department Bureau of Bridges for the purpose of developing a test method whereby the load-bearing capacity and the required length of piling under bridge footings could be determined in advance of construction is given in the June Engineering Experiment Station News of the University by K. V. Taylor, Bridge Foundation Engineer, Bridge Bureau, Ohio Highway Department. He states that since the fall of 1932 when the field work was started a quantity of data has been collected that definitely shows the value of the test method developed.

The apparatus in use during the past two years is essentially a small drop-hammer pile driver, equipped to drive a sectional, pointed, steel rod. This device was carefully calibrated in terms of full-size load-bearing piles, and the predictions as to pile requirements, based on this calibration, are being continually checked against actual construction.

Up to the present time the original testing machine has been used on 43 widely separated bridge sites throughout the state and has driven 188 individual tests. The test holes vary in depth from 5 ft. to more than 80 ft., the total for all tests being over 5,400 ft. After each job was completed, and the field notes properly correlated, recommendations were made to the Bridge Bureau regarding the necessity of piling, and if piling was found necessary, the probable length required for a given static load. These reports also included data as to the safe load-bearing power of the soil, the underground water conditions, analyses of the soil samples collected, and complete descriptions of the underlying strata.

During the construction of the foundations where the tests were made, the results of the tests were compared with the actual conditions. If piling was driven, a record was kept showing the foot-by-foot penetration and calculated bearing power of every pile. In some instances the piles were subjected to static load tests. The actual bearing power was then compared with the predicted value.

The results of the test system up to the present time have been quite gratifying. Not all of the 43 bridges have been built, but on the ones that have the foundation conditions have been very closely in accord with the predictions. On nearly all of the structures the total lineal feet of piling actually driven to required bearing has been within 5 per cent of the estimated footage. In every case the test has been quite accurate in determining the subsoil characteristics, location of various strata, etc., and has proved to be more reliable than the ordinary drilling methods.

A new and improved machine for making soundings by this method is nearing completion in the University machine shops. This machine has the drop-hammer mechanism, a 3-in. churn drill, a small core drill, pulling apparatus for removing the drive rods, and mechanism to enable it to move about on the site under its own power.

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HIGHWAY LIGHTING EXPERIMENTS IN CANADA.—Experimental lighting of Canadian highways is under way in Ontario and Quebec. Tests are being made on an eight mile section of heavily traveled highway between Stony Creek and Grimsby, Ontario. In Quebec, a one-third mile test stretch is to be constructed by the Board of Trade of St. Johns, Quebec, and another experiment in highway lighting is projected in the vicinity of Shawinigan Falls.

EDITORIALS

A Prospective Long Drought

THE writer's research on weather cycles, which has been almost continuous for seven years, has reached a point that enables him to say that at least four long rainfall cycles of great enough amplitude exist to cause prolonged dry periods. They are cycles of 60, 70, 270 and 178 years. It happens that the first three of these cycles will have their next valley or extreme drought simultaneously in 1940. Of cycles shorter than 60 years, none is more important than a cycle of 36 years, whose valley will be next year. The 10-year cycle has a peak in 1935, which will somewhat mitigate the drought effect of the 36-year cycle. The cycle of 22.24 years, which has its peaks at alternate peaks of the 11.12-year sunspot cycle, had its last rainfall peak in 1928, and will have its valley in 1939.

These dates of maxima and minima have been established mainly by means of the thickness of tree-rings. The trees having the longest record measured by Prof. A. E. Douglass are the sequoias of California, going as far back as 1310 B. C., and the pines of Arizona as far back as 1390 A. D.

The summer rainfall of the upper Mississippi Valley has the same phase as that of the winter rainfall of California, which enables us to apply to the Mississippi Valley the peak and valley dates of cycles in the California redwoods (sequoias).

Certain regions in the northern hemisphere have opposite phases for the same cycle; that is to say, in a year when one region experiences a drought, another region has heavy precipitation. New England winters, for example, are apt to be very snowy during a period when the upper valley of the Mississippi is very dry.

Not since the white man settled the Mississippi Valley have the cycle conditions been so unfavorable for rainfall there as they will be in 1940 and for many years before and after that date. This spells very poor crops and inadequate water supply for hundreds of cities and towns.

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The Diversion of Highway Funds

DIVERSION of gasoline taxes to other purposes than highway uses is illegal in New York and certain other states, yet in New York that provision of the law has been ignored during the past two years. Study of the statutes of other states will probably disclose similar disregard of law.

In Illinois the lower court has ruled that diversion of the state's share of the gasoline tax is illegal. No appeal from that decision has been taken.

In Ohio a lower court decision forbids the diversion of gasoline tax funds by cities.

In Minnesota the attorney general has advised that highway funds can not be diverted legally.

In Colorado the supreme court has declared unconstitutional a law that provided for the use of motor-vehicle license fees for other than highway purposes.

The legislature of Pennsylvania recently defeated a bill that provided for diversion of gasoline tax funds.

These cases and instances indicate that both the courts and certain state legislatures are opposed to gasoline tax diversion.

The American Road Builders' Association can, and probably will, render invaluable service to motorists and to the highway industry by leading the fight against present and proposed diversions of highway funds. About $80,000,000 annually are being thus diverted. If even half this unjustified diversion can be stopped soon by the aid of the A. R. B. A. the indebtedness of the public to it will be enormous; for in most instances these diversions of highway funds have served only to delay a reduction in property taxes that must eventually occur.

Gasoline taxes are tolls for the use of highways, and they should always be used only to pay for highway maintenance and improvement and interest on highway bonds. There is no more justification for the diversion of highway funds for school or other purposes than for a similar diversion of the income from water works plants. Each tub should stand on its own bottom. An emergency is no excuse for turning a financial tub upside down, for that merely robs Peter to pay Paul.

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The Maligned "Profit Motive"

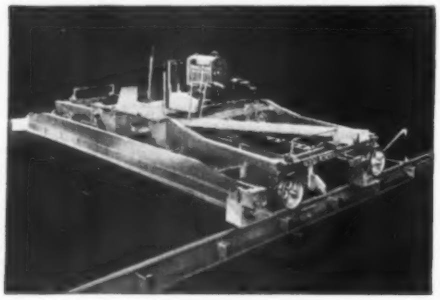
THE "profit motive" has been the subject of many recent disparaging remarks by certain political officials of high rank. Some of these officials call themselves economists. Yet if there is one principle that economic history has established beyond question it is that payment in proportion to efficient performance is the most effective way of securing economic progress. No economist now questions this principle when applied to wage or salary earners. Then why should it be questioned when it is applied to profit makers? In America profits are usually the monetary rewards for economic efficiency in the face of severe competition. The outstanding example of a successful profit maker is Henry Ford. He will eventually be the best classic example of the wisdom of an economic system that enables an individual to earn great profits, for it was he who introduced high wages on the greatest scale that America had witnessed, yet coincidentally earned the greatest profits.

Many men of the academic type who have thought about everything and done nothing that pertains to anything in business, are inclined to belittle the "profit motive." They go farther, and often speak of it as if it were unethical to make large profits. But if profits are the wages of successful management, those academicians are urging us to curb successful managers. Indeed they would scourge them from the temple as "money changers" who are defiling a sanctum. They would have us believe that no great wealth is acquired save by underpayment of the workers, although American economic history shows that per capita wealth has kept almost exact pace with per capita wages, and that the American worker is the best paid in the world. They conveniently neglect to point to the regimented Hindus—regimented by caste and by religion—who have no Fords or Rockefellers. But they raise a great howl of criticism when an industrial system that had worked well for 40 years, then worked badly for 5 years. Between the depression of 1893-8 and that of 1929 to the present, there was no depression of great general severity or of long duration. While it can not be said that our industrial system was perfect, at any rate it was the best that had evolved, since men began experimenting industrially thousands of years ago. Under that system not a single famine in America has occurred since the signing of the Declaration of Independence.

NEW EQUIPMENT AND MATERIALS

New Jaeger-Lakewood Finishing Machine

A new combination of automatic, high speed operation with velvet touch screeding is claimed for the new Type "D" Finisher, just placed on the market by the Jaeger Machine Co., Columbus, O. It is claimed that the rigid, box-type 12-inch screeds, moved evenly and smoothly by double equalizing connecting rods with link motion, and with toggled radius rod construction which eliminates all radial swing, give a new roadability to concrete and bituminous surfaces and eliminate most of the costly hand work behind the finisher. Positive, automatic power lift raises and lowers the heavy screeds in 2 seconds. Each screed is independently controlled.



Standard Gasoline Model

The machine has working speeds of 8 and 12 ft. per minute forward and 40 to 90 ft. reverse, combined with automatic increase of screed strokes to a maximum of 36 cycles or 72 strokes per minute.

Automotive type transmission, with heat-treated chrome vanadium gears and shafts carried on Timken bearings and running in oil, drives direct to all four wheels. Built-in differential and brakes permit steering with a lever to straighten machine on the forms and to round curves. Telescoping rigid steel frame for quicker 2 ft. width adjustments; accessible, 75 per cent faster crown resetting and adjustments; 14-in. wheels mounted outside for quick changes; Timken bearings throughout and new transportation device, which eliminates all blocks and shoring, are other features emphasized by the manufacturer.

Jaeger-Lakewood vibrating attachment, mounted direct on screeds and used successfully on many jobs, is offered in combination with bullnose front screed.

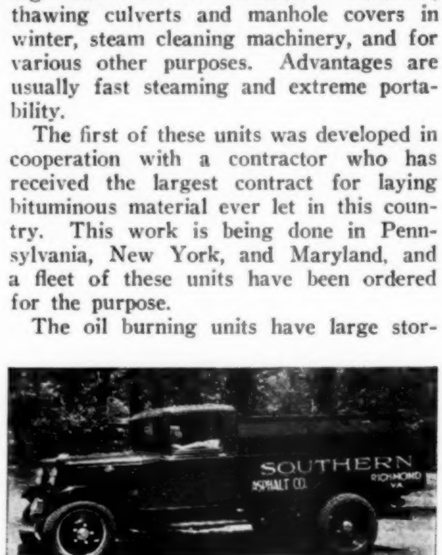
The standard Type "D" machine shown above is furnished with 4-cylinder 10-15 h.p. gasoline engine with flexible throttle control for intermediate speed ranges. The same machine is also built with gas-electric power, the engine and generator producing current for the operating motors with reserve power sufficient for extra load where vibrating attachment is used and also for operating lights when needed on the job. Bulletin 41-G, which describes the Model "D" in detail, has just been issued by The Jaeger Machine Co., Columbus, O., the manufacturer.

Steam Heating Plant Mounted on Truck

By mounting an oil burning boiler on a high speed truck, Cleaver-Brooks Co., Milwaukee, Wis., has worked out a new idea in portable s.eam heating plants for heating tank cars of bituminous materials, thawing culverts and manhole covers in winter, steam cleaning machinery, and for various other purposes. Advantages are usually fast steaming and extreme portability.

The first of these units was developed in cooperation with a contractor who has received the largest contract for laying bituminous material ever let in this country. This work is being done in Pennsylvania, New York, and Maryland, and a fleet of these units have been ordered for the purpose.

The oil burning units have large storage tanks for water and fuel oil. From a cold water start, they develop full working steam pressure in 30 minutes, have exceptionally high efficiency and controlled heating capacity. Previously, these units have only been mounted on trailers.



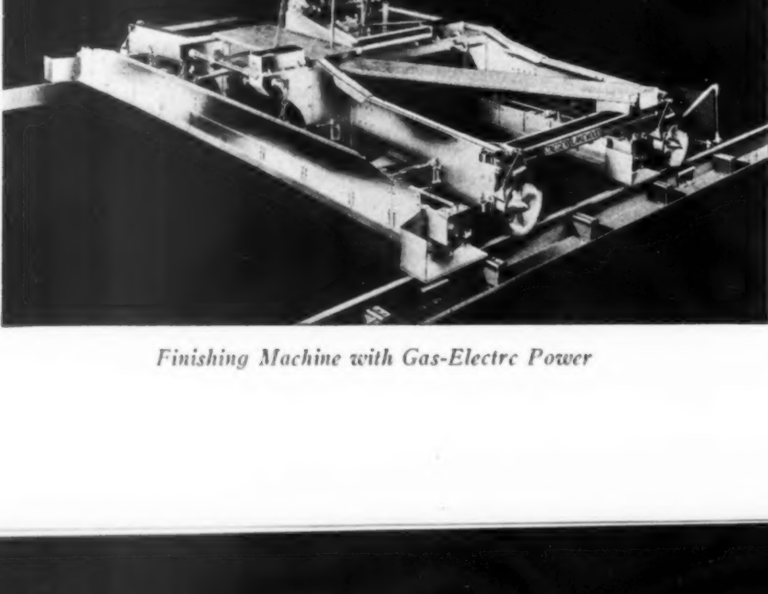
Steam Heating Unit Mounted on Truck

New Belt Conveyor

A new belt conveyor has been brought out by the Northern Conveyor Co., Janesville, Wis. Some of the outstanding features claimed for it are:

The loading end is so designed that it positively prevents material getting between the belt and the lower roll. It is equipped with accurately balanced troughing idlers, rigid crown faced drum with mountings on the head shaft right next to the boxes giving long life to the shaft and boxes. Its frame is sectional and the sections are interchangeable. It is mounted in a handy truck with roller bearing wheels, easily operated raising and lowering device and the wheels are arranged so that they can be pivoted, placing them on the circumference of a circle with the center at the loading end of the conveyor, permitting the conveyor to be pivoted on the loading end, thus discharging the material in the arc of a circle.

New Belt Conveyor of Northern Conveyor Co.

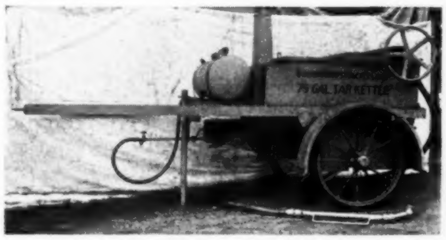


Finishing Machine with Gas-Electrc Power

New Heating Kettle

Good Roads Machinery Corp., Kennett Square, Pa., announces the addition to their present lines of the "Good Roads" Champion heating kettle. At present two sizes of these kettles are available, with capacities of 75 gal. and 110 gal. each. Spring mounted, with roller bearing steel wheels and solid rubber tires as standard, although pneumatic tires can be furnished when desired. A pressure fuel tank of ample capacity is safely located at the forward end of the kettle. The burner, a highly approved type, is securely locked into place when heating the tank but is quickly removable, and available for weed burning, surface warming, or other required use when necessary.

By means of a simple but effective process of baffling, a positive return circulation is secured resulting in a quick heating of the material. The same feature acts to eliminate the danger from flashing, and reduces the coaking element to a minimum. By eliminating all vents, the escape of burned gases is prevented except through the stack—a source of protection and comfort to workmen using this equipment.



"Good Roads" Champion Heating Kettle

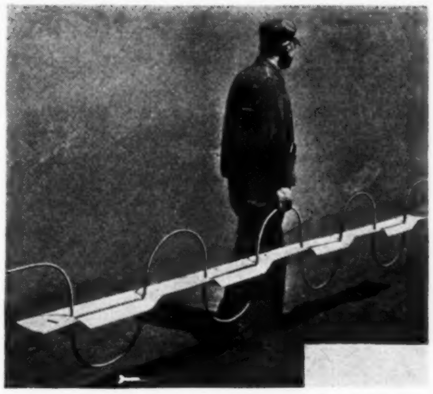
"Good Roads" Champion heating kettles are furnished with or without the hand operated submerged pump, located on inside bottom of tank at rear. A 15-ft. heavy duty metallic hose equipped with very effective maintenance patching nozzle is standard with all kettles with pumps.

Proper screen is provided for the holding back of cold material as added, permitting the drawing of heated material only without interruption or delay. The general overall dimensions of the 75 gal. kettle are: Length 11 ft. 3 in.; width, 4 ft. 10 in., and height 5 ft. 3. in. (to top of stack). The wheel tread is 4 ft. 3 in., insuring excellent stability and balance when kettle is trailed at high speeds.

Lacing the Nation's Roads

The illustration shows a section of the Smith metal laced joint being carried into place—and which will run in a longitudinal position between slabs. The result, in engineering language, will be a lacing together of the slabs plus an interlock or transfer of load vertically. In other words, the tying feature conforms to the well known rule that "small members closely spaced are more effective than larger members widely spaced."

The section consists of but two parts and handles as a single unit. The entire procedure, it is claimed, is quite simple and adds greatly to road life and strength. The Smith metal laced joint is a product of the A. O. Smith Corporation, and is distributed nationally by the American Steel & Wire Co.



Section Smith Metal Laced Joint

New Portable Oxweld Generator

The Linde Air Products Co., 30 East 42nd St., New York, N. Y., has just announced a new Oxweld generator, known as the Oxweld Type MP-4 portable acetylene generator. It is intended for portable service only, and is specially designed to withstand the abuse encountered in such service, particularly in overland pipe construction. Having a carbide capacity of 150 lb., it will be of great service wherever large scale welding operations must be carried out in the field.

The capacity of this new generator is 150 lb. of ¼x1/12-in. (quarter size) carbide. The generator is listed as standard by the Underwriters' Laboratories, Inc. It is rated to produce 300 cu.ft. of acetylene per hour. It weighs 750 lb. empty, is 87 in. over-all in height, and 42¾ in. in diameter. Fully charged the generator weighs 2,250 lb.

The feed is of the gravity type. The mechanism is of a most advanced design, unlike previously employed gravity feed devices. The feed control unit is self-contained and is bolted to the inside of the carbide hopper. The feed valve unit is actuated by a diaphragm. Pressure on the diaphragm is exerted by a housed and loaded spring unit. The spring is encased in a small housing and set at the factory to deliver about 13 lb. per square inch presure. This can be changed within a range of about 2 lb. per square inch by an external adjustment. The set pressure feature does away with the necessity of setting the pressure when the machine is started.

New Oxweld Type MP-4 Portable Acetylene Generator

At all rates of generation, the pressure variation within the generator is not more than ¼ lb. per square inch. This slight variation is removed by means of a new type of regulator designed for this particular job. This regulator, Oxweld Type R-56, is a large unit built into the generator in a novel and ingenious manner.

New 6-Yd. and 8-Yd. Carry-All Scraper

R. G. Le Tourneau, Inc., Stockton, Calif., designers and builders of pneumatic tired dirt-moving equipment for the contractor, announces the addition of the 6-yard and 8-yard Carry-all Scrapers to the Le Tourneau line. These two new carriers have been built to supply the need for smaller scrapers to be used with 30, 35 and 50-tractors. They are identical in design with the popular 12-yd. carry-all, except for their capacity of 6 yd. 8 yd. (loose measure), respectively. Many of these new units have been built and are in operation on the West Coast as well as in other parts of the country. They are being used on highway construction, land leveling, stripping operations connected with placer mining and dredger work.

8-Yard Carry-all

The Le Tourneau Co. has placed 46x20x10-in. tires, carrying an air pressure of 30 lb., on these new scrapers. Heavy duty Timken bearings also are used.

Chevrolet Flat-Faced Cowls Introduced

An innovation in motor truck practices is announced by Chevrolet Motor Co. with its introduction of the flat faced cowl offered as optional at no extra cost on its 112, 131 and 157 wheelbase models. The new design permits the use of a Chevrolet chassis with any custom body built for a flat cowl. The new construction was designed for the benefit of the many vocations using special bodies, such as school buses, single unit refrigerator bodies, public utility construction bodies, contractors' dump bodies, and other types that do not utilize separate cabs. The regular Chevrolet truck chassis carries a streamlined treatment of the hood, cowl and front pillar posts. On trucks of the three wheelbases listed, the flat faced cowl trucks give, respectively, the following distances from the face of the cowl and the rear end of the frame: 104 7/16 ins., 124 5/16 ins., 150 5/16 ins.

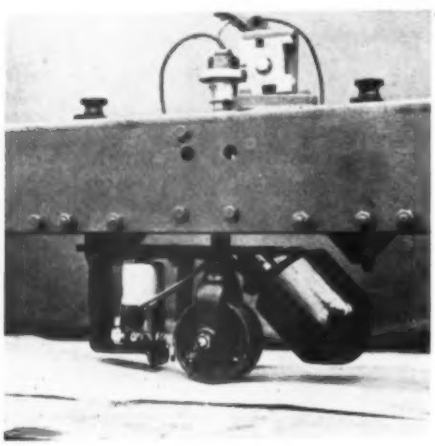
Cold Rolled Phosphor Bronze Plates for Bridge

Metallurgists of the Anaconda Copper Co. have developed a cold rolled phosphor bronze plate for use as bearing and expansion plates in bridges. The plates not only satisfy the tensile strength and compression values of the A. S. T. M. specifications for bridge plates, but, being a wrought material, insure freedom from porosity and minimize the possibility of breakage. Cold rolled plates have a smooth, uniform surface and can be installed without machining.

In addition to physical and engineering advantages, bridge plates of cold rolled phosphor bronze are stated to have proven more economical to use than cast plates of the same metal. Because they are furnished to the job, sawed accurately to dimensions and drilled for rivet or bolt holes, they can be put in place immediately without the time and expense previously required for machining and fitting.

A Road Surface Tester

A new road surface tester for locating the high spots and depressions beyond allowable limits is being manufactured by the H. & H. Mfg. Co. of Elyria, O. It consists of a framework on wheels on which is mounted a free-moving roller with an extension arm, constructed so that the roller with its extension arm can follow the profile of the road independently of the truck wheels.



A Solenoid Valve Is Mounted on the Arm

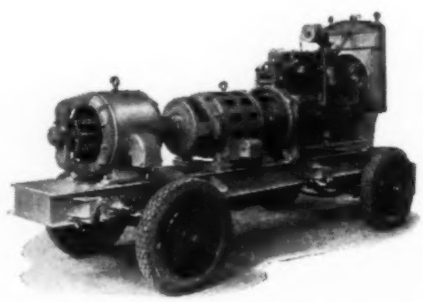
The upper part of the extension arm is arranged to establish a contact if the roller moves in either direction beyond permissible limits. Whenever this contact is made, a G-E solenoid valve, which is mounted on the frame, is energized, opens, and squirts a stream of marking fluid on the defective spot.

The contact established by the extension arm also lights an indicating lamp on the upper part of the road tester, so that the crew foreman may make a preliminary inspection of the defective spots as the tester moves over each section of the road. The lamp and the solenoid valve are operated from a 6-volt battery on the tractor which pulls the tester.

Emergency Power Plant

This portable power plant, built by the Harnischfeger Corporation, Milwaukee, Wis., for a large Eastern public utility, is seeking its first service as an emergency unit supplying power for interrupted service in outlying districts where power lines are not immediately available and for portable tools on construction work.

The 50 K.W. capacity engine driven generator set furnishes either 230 volts D. C. or 230 volts, 3 phase, 60 cycle alternating current. Either current or both are available for any job up to the capacity of the driving engine. The D. C. unit acts as the exciter for the A. C. unit. Permitting the operation of any number of electrified drives without installation of expensive power lines, this unit has a wide range of usefulness, including its application as a power unit for contractors, industrial emergency use or for a number of purposes around the large farm or ranch. As a trailer unit, it is practical for any kind of field service.



New Portable Emergency Power Plant

It is also finding favor among crane operators where power is switched from D. C. to A. C. Such operators show considerable savings by installing a motor generator to maintain the superior D. C. control without the necessity or expense of changing over motors, brakes, and controls to meet A. C. requirements.

Webb Appointed Sales Manager Universal Atlas

Appointment of C. A. Webb as sales manager of the Universal Atlas Cement Company, a subsidiary of the United States Steel Corporation, is announced by F. L. Stone, vice president and general sales manager of the company. He will have charge of the Chicago metropolitan territory. The remainder of Illinois and Indiana, lower Michigan and southern Wisconsin remain in charge of Edward Quebbeman, sales manager.

Mr. Webb has been connected with the Universal Atlas company for 17 years, including a leave of absence at the time of the World War when he served in France as an officer in the American army. He formerly was district sales manager for the company.

Western-Austin Officers Elected

At a meeting of the stockholders on June 21st of the Austin Manufacturing Company of Harvey, Ill., and the Western Wheeled Scraper Company of Aurora, Ill., consolidation of the two companies to form the Western-Austin Company was officially approved.

The Austin-Western Road Machinery Company will continue to handle sales for the new corporation, and the home office of both companies will be at Aurora, Ill.

The newly elected officers of both companies are as follows: C. W. Sencenbaugh, chairman of the board; S. F. Beatty, president; H. B. Bushnell, vice-president; K. N. Forbes, vice-president; F. L. Jerome, vice-president; H. M. Kleiser, vice-president; J. L. McNab, secretary; McClure Kelley, treasurer.

According to S. F. Beatty, president of the new corporation, operating economies, increased efficiency and improved service to Austin-Western customers will result from the consolidation.

A district sales office under the supervision of E. J. McGinty will be maintained in Chicago at 105 W. Adams St.

View of the new headquarters of the Western-Austin Company and the Austin-Western Road Machinery Company at Aurora, Ill.